

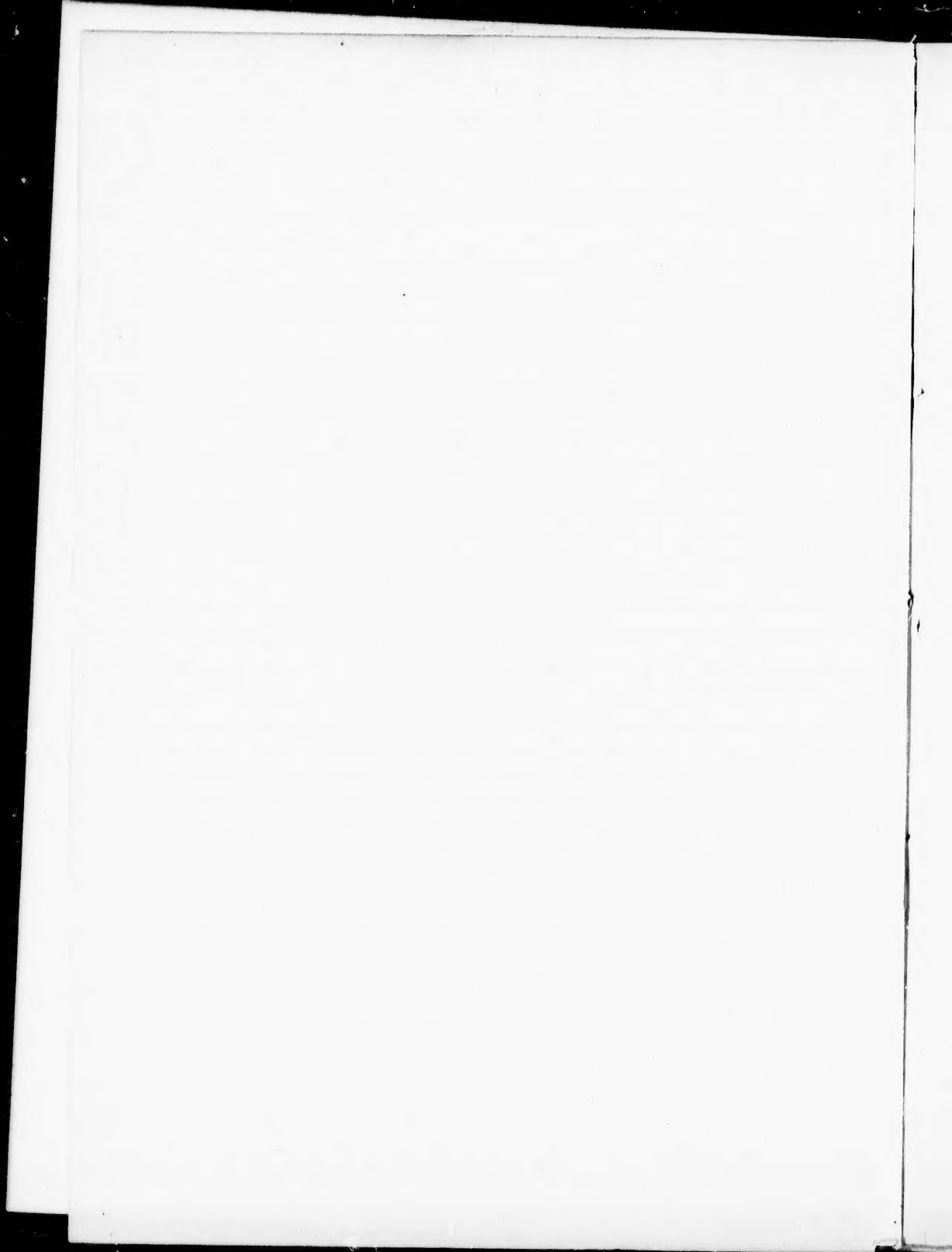


John Le Conte

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PORTRAIT OF MAJOR JOHN LECONTE.

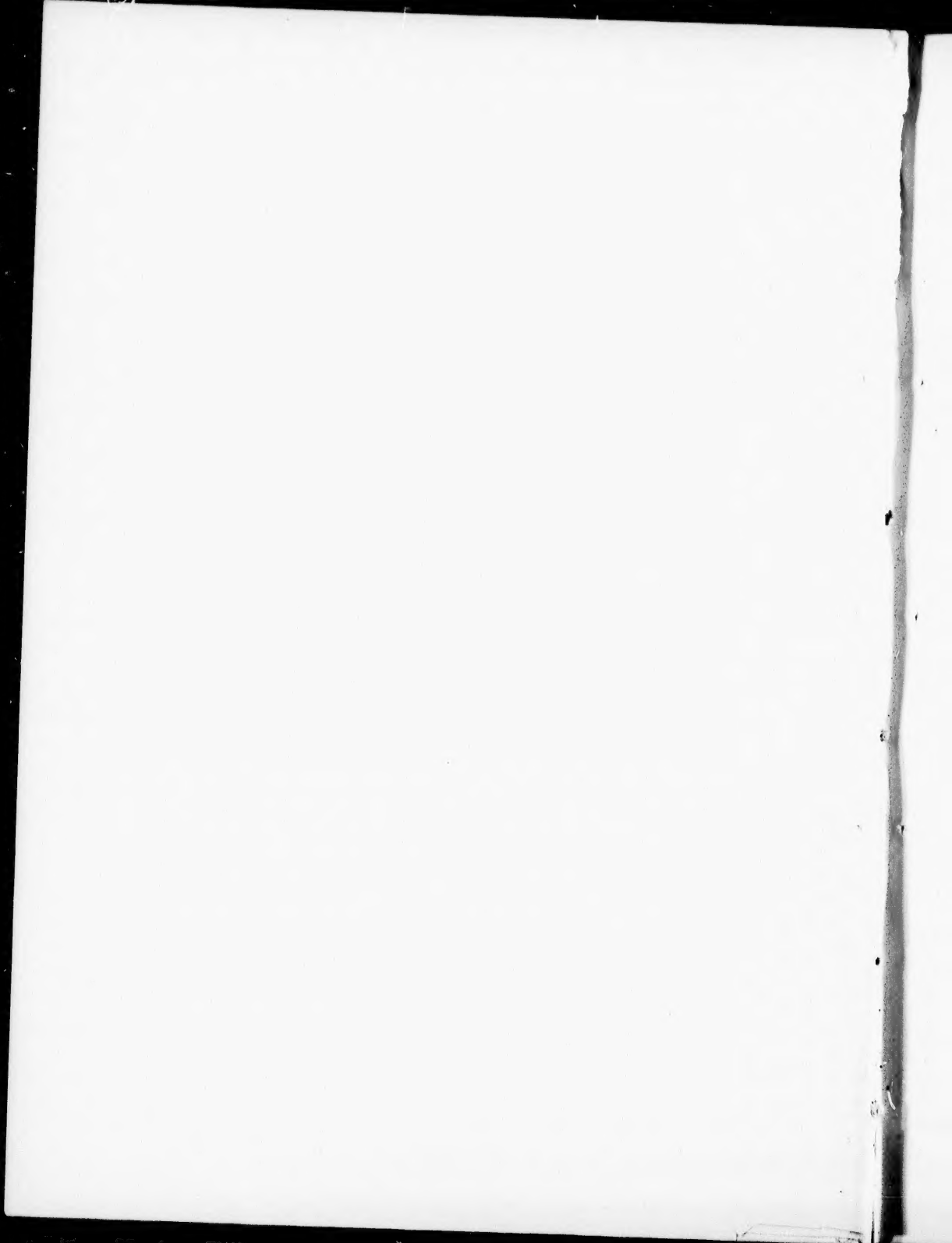
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THE
BUTTERFLIES
OF THE
EASTERN UNITED STATES AND CANADA
WITH SPECIAL REFERENCE TO
NEW ENGLAND.

VOL. II.

ENTOMOLOGICAL BRANCH
DEPARTMENT OF AGRICULTURE
OTTAWA - - CANADA



THE
BUTTERFLIES
OF THE
EASTERN UNITED STATES AND CANADA
WITH SPECIAL REFERENCE TO
NEW ENGLAND.

BY
SAMUEL HUBBARD SCUDDER.

IN THREE VOLUMES.

VOL. II.
LYCAENIDAE, PAPILIONIDAE, HESPERIDAE.



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II.

FAMILY LYCAENIDAE.

GOSSAMER-WINGED BUTTERFLIES.

Rurales Fabr.; Ruricoles Walck.; Ruralla Erycinens Blanch.-Brullé; Erycini Luc.;
 Grav. Erycinidae Swains.
 Plebeii rurales Linn. Onisciformes Newm.
 Lycaenidae Kennie.

Tandis qu'un papillon, les deux ailes en fleur,
 Teinté d'azur et d'écarlate,
 Se posait par instants sur la peau délicate
 En y laissant de sa couleur.

LECONTE DE LISLE.—*Le Manchy.*

Your mistresses dare never come in rain,
 For fear their colours should be wash'd away.

SHAKESPEARE.—*Love's Labour's Lost.*

Imago. Of small size. Head rather small; front always higher than broad, usually half as high again as broad; vertex separated, sometimes partly, sometimes wholly, from occiput by a transverse sulcation; eyes neither prominent nor projecting beyond the general contour of the head. Tongue inserted below the middle of the lower half of the eye; papillae of tongue very long and slender, polyhedral, equal, the angles terminating at the truncate or hollowed tip in acicular points, the central process exceedingly slender, blunt tipped; they are attached close to the outer edge of the tongue, confined to the apical tenth or thereabouts and are always separated from each other by at least half their own length. Antennae inserted in distinct pits, so far at the side as to infringe upon the eyes, the middle in direct continuation with the sides of the front; the club straight. Labial palpi very slender, cylindrical, of nearly uniform diameter.

Prothoracic lobes reduced to a mere lamina. Thorax moderately slender, not much compressed, the upper surface moderately arched, sometimes a little less so above; mesoscutellum pretty large, lozenge-shaped, forming about a right angle between the halves of the mesoscutum into which it does not greatly project, the suture between the two slight, the two pieces together forming posteriorly a reversed blunt cone; metathorax only slightly separated from the mesothorax. Wings almost always broad and short, the fore wings almost invariably simple, the hind wings frequently with thread-like tails. Fore wings: costal nervure terminating at from a little less than half to about two-thirds the distance from the base to the apex of the costal margin; subcostal nervure with two or three superior and one inferior branches; all simple excepting the last superior which is frequently forked; at least one of the superior branches is emitted before the tip of the cell, and the third, when present, beyond; the inferior nervure united to the nervure by a very slender vein; the nervure itself terminates below the apex of the wing; cell closed by a slender vein sometimes almost obsolete; median nervure with three branches, itself not reaching the border; internal nervure short, running into the submedian nervure close to the base. Hind wings: costal

nervure terminating at or near the middle of the apex of the costal margin, sometimes emitting upward from near the base a curved precostal shoot; subcostal nervure with three branches, itself not reaching the border, the third nervule connected at its base by an exceedingly slender vein, such as closes the cell; median nervure with three branches, itself not reaching the border; submedian nervure terminating at or just without the anal angle; internal nervure terminating generally near the middle of the inner margin. Fore legs of the female like the other legs, although with less profuse armature; and with naked tibial spines; of the male shorter, and either the armature and joints as in the female, excepting on the last joint, where all the apical armature is wanting and in their place generally a single, triangular, slightly curving median hook; or the tarsi are one-jointed and entirely devoid of armature.

Eighth dorsal segment of male abdomen entire on posterior margin, the upper organ mesially cleft and the sides variously developed, but usually much expanded, with a pair of slender, tapering, elbowed or strongly arcuate arms attached to the base, and with no median hook; claspers forming slender and elongated or else tapering blades, sometimes bristled at the tip, the intermittent organ long and slender, often to an excessive degree.

Egg. Tiarate or oblate spheroidal in shape, more or less deeply and densely reticulate, the angles of the reticulations often filamentous or spiny, the micropyle frequently sunken in an abrupt pit.

Caterpillar at birth. Head generally smaller, never larger than the succeeding segments, smooth, generally with few hairs on the lower half and none on upper, the posterior margin encroached on by the softer integument behind so as not to extend behind the summit of the head in a downward curve. Body cylindrical or subcylindrical, generally largest anteriorly and tapering from the very front backward, furnished with long, longitudinally ranged, tapering, spiculiferous, cuticular appendages, sometimes as long as the body, and with a larger or smaller number of longitudinally ranged, larger or smaller chitinous annuli or smooth lenticular elevations. First and last body segments, and sometimes others, with a corneous dorsal shield.

Mature caterpillar. Head smaller, generally much smaller, than the body, oblique, the mouth being thrust forward, with only few hairs on minute papillae, without tubercles or spines, with scarcely any or no posterior contractions of the cranium, often completely retractile within the segment behind. Body onisciform or subonisciform, never elongate, often long-ovate, the sides sometimes tectiform, furnished with longer or shorter pile, among which are sometimes longer, longitudinally ranged, hairs or bristles; never spined, but occasionally furnished with fleshy or filamentous processes longitudinally arranged or confined to the first thoracic or eighth abdominal segments. Legs and prolegs generally short.

Chrysalis. Fastened by a silken girth around the middle and by cremastral hooks to a silken pad at the tail, in almost any position, but with the head never lower or much lower than the tail and always in close embrace of the surface*. With rare possible exceptions (Bar), never enclosed in more of a cell than the loose attachment of the flaring edges of a leaf might give. Short, stout, compact, rounded, with no angular and few rounded prominences, in front bluntly rounded, though sometimes feebly emarginate, the ventral surface almost perfectly flat; head wholly upon the ventral surface, invisible from above; prothorax large.

General characteristics of the family. This family is far more richly developed in the tropics—especially in those of the New World—than in the temperate zones. In the north temperate regions of the Old World, however, it forms a very considerable proportion of the butterfly

* A few instances are known among the members of the higher subfamily in which the chrysalis is held without a girth, in a rigid

position (generally, perhaps always) very similar to what they would have if closely girt.

fauna, although exhibiting but a limited number of generic types. In North America it is feebly developed except upon the western coast; elsewhere it is largely outnumbered both by the Nymphalidae and the Hesperidae.

The butterflies of this group as a rule are smaller than those of any other family, not excepting the Hesperidae, from which they are quickly distinguished by their more vivid colors and generally gay attire. Their delicate and brilliant markings, together with the nimble and varied flight of many, scarcely excelled by the most vivacious of the Nymphalidae, mark them as gems in the lepidopterous world. Their wings are almost always entire excepting when the inner half of the hind wing develops a tail, often of excessive length and delicacy, a mere thread of color. In the structure of the fore legs this group stands midway between the Nymphalidae and the Papilionidae. Those of the female are always perfectly formed though usually slightly smaller than the middle pair; while those of the male are always more or less atrophied, yet never to the extent that prevails among Nymphalidae*.

The caterpillars may at once be distinguished from all others by the small size of the head, their more or less onisciform and never elongate shape and by the brevity of their legs and prolegs, forcing some of them to glide rather than creep. Not a few are known to avail themselves of their small head, extensible neck and oblique position of the mouth, to burrow into pods, seeds and fruit. The chrysalids are broad in proportion to their length, seldom, and then very slightly and roundly, angulated and are not only attached by the hinder extremity as those of the previous family, but tightly girt by a silken cord, passing around the body near the division between the thorax and abdomen; their inferior surface is nearly straight, and closely pressed against the surface to which they are attached. In one or two instances they secure a similar position by the tail fastenings alone, probably from the length of the cremastral area and the rigidity of the abdominal joints.

Division of the family. In the lists and other systematic papers that I have published within the last ten or fifteen years, I have ventured to depart from the ordinary custom of entomologists by considering the Lemoninae and Lycaeninae as subfamilies of one great group, instead of classing them as distinct families; but my reasons for this conclusion have never been fully stated. In brief, it may be said that these two groups bear to each other almost identical relations to those borne to each other by the Pierinae and Papilioninae. Those who consider these two latter groups as members of a single family should regard the Lycaenidae as

*Godman and Salvin have recently described a genus *Theclopsis* in which "the fusion of the joints of the tarsus and the

elimination of the claws" has "never been carried out." The species come from Central America.

forming a family group of similar significance. The structures upon which one may draw for the characterization and delimitation of this group will be discovered in every stage of life. The egg differs in a very marked manner from that of any other group however small among butterflies (with the single exception of the Parnassians), in being universally broader than high, oblate spheroidal, and generally turban-shaped. The agreement of the two subfamilies, *Lemoniinae* and *Lyceninae*, in the characteristics at this stage of life are so complete that it is impossible with our slight knowledge of the former, to formulate any satisfactory diagnostic distinctions; and they wholly differ from the egg of the Parnassians in the character of the surface sculpture, the cells of the reticulation being lower than the bounding walls, while in the Parnassians the reverse is the case, giving them the appearance of being covered with plates.

The caterpillar as it leaves the egg is distinguished by the presence of chitinous annuli or lenticular elevations, serially arranged on the dorsal side of the body; these are not found at this stage, at least in the same region, in any other group, and they are here found in both of the subfamilies. The adult caterpillar is remarkable for its generally onisciform shape, so that in the *Lyceninae* at least they are recognizable at a glance; but even where they are cylindrical they differ from those of every other group in their abbreviated form. In the other subfamily, the *Lemoniinae*, there is greater variability of form, but we never find any with the great elongation of the body characteristic of all the other families. In both they differ from most others and agree together in the incomplete structure of the posterior part of the head, the chitinous skull presenting here no downward slope, the softer membrane of the succeeding segment being attached to the skull near the summit of the head, so that the head becomes more or less retractile, sometimes certainly to a very slight degree, within the first thoracic segment, while the head itself has a very decided obliquity. These last characters, however, they share to a certain extent with the family *Papilionidae*.

The chrysalids of the two groups agree with each other again and differ from those of all others in their compactness and brevity, while at the same time they offer one peculiarity, found in no other group and which holds here throughout both; viz., the head cannot be seen from above, being bent over and forming a part of the ventral surface only; sometimes the same is true of the last abdominal segment. The prothorax, too, is proportionately larger than in any other group, and these peculiarities of the head and prothorax the two subfamilies hold in common. Add to this the character long known to be peculiar to them, the close girdling of the chrysalis, with the flatness and uniformity of the ventral surface, characters which with rare exceptions they share together and in which they differ

from all other butterflies, and it will be seen that the lower stages of these two great groups of smaller butterflies have quite as many and as important characters in common, if not, indeed, far more in number and value, than can be found in any other group of subfamilies among butterflies. It is quite true that our knowledge of the early stages of the Lemoniinae, of which we shall give a summary further on, is ridiculously small, but inasmuch as those of whose transformations we are aware in no way contravene the statements made above, we judge that the two groups should be rightly considered as intimately associated, until the contrary be proved by future observations.

In the perfect stage, we also find important characters common to these two groups and distinguishing them from the rest of the butterfly world. Their small size and delicate structure would at once be remarked; the front of the head between the eyes is much narrower than high, which is not true of any other group; the eyes are not in the least prominent, and they are notched on the inner margin above to give room for the antennal sockets, which the narrowness of the head between the eyes here renders necessary. As all these are characters which concern the fundamental structure of the head and are not found elsewhere, they must be regarded as of considerable taxonomic weight. The antennae, including the club, are invariably straight, with none of the curves so common elsewhere, and especially in the lower groups. Both of the subfamilies agree with the Nymphalidae in the slight separation of the meso- and metathorax. The venation of the wings is extremely simple. The structure of the front legs has been so often insisted upon that it is not necessary to more than mention it, but it should be borne in mind that the difference between the two subfamilies is comparatively slight, while they both differ from all other butterflies in the broad fact that the front legs of the male are, and those of the female are not, aborted; in no other group, excepting in the single aberrant subfamily Libytheinae (on that account placed here by Bates), are the legs sexually heteromorphous, while here it is universal, though varying in degree. The difference between the two subfamilies is that of degree; the difference between the family and other families is one of independent character. Add to this the unique character of the abdominal appendages of the male shared by both the subfamilies and we have a totality of characters drawn from all stages, held by these two groups in common and in distinction from others, which cannot be exceeded by any other combination of subfamilies in a homogeneous whole.

Table of subfamilies of Lycaenidae, based on the egg.

Converging septae extending from the walls of the cells toward their centre....**Lemoniinae.**
No converging septae thrown off from walls of cells.....**Lycaeninae.**

Table of subfamilies, based on the caterpillar at birth.

Body with chitinous dorsal and substigmatal shields on every segment, to which the haired papillae are confined, and only subdorsal annuli.....**Lemoniinae.**
 Body with chitinous dorsal shields of greater or less extent and distinctness only on first thoracic and last abdominal segments, no substigmatal shields, and with annuli on the sides of the body.....**Lycæniinae.**

Table of subfamilies, based on the mature caterpillar.

Head at least half as broad as the middle of the body; the latter scarcely unisiform.....**Lemoniinae.**
 Head less, generally far less, than half as broad as the middle of the body; the latter more or less unisiform.....**Lycæniinae.**

Table of subfamilies, based on the chrysalis.

Body elongate, sparsely clothed with long hairs.....**Lemoniinae.**
 Body contracted, sparsely or densely clothed with short hairs or other dermal appendages.....**Lycæniinae.**

Table of subfamilies, based on the imago.

Labial palpi minute, only the minute apical joint surpassing the face; fore wings provided with a distinct internal nervure; hind wings scarcely channeled to receive the abdomen, furnished with a precostal nervure, the costal nervure only running to the middle of the costal margin; fore tarsi of male, with rare exceptions, without spines or claws.....**Lemoniinae.**
 Labial palpi well developed, porrect, half or more of the middle joint surpassing the face; fore wings with excessively brief, hardly perceptible, internal nervure; hind wings channeled on basal half to receive the abdomen, without a precostal nervure, the costal nervure running nearly to the end of the costal margin; fore tarsi of male armed abundantly beneath and at tip with spines.....**Lycæniinae.**

SUBFAMILY LEMONIINAE.

ERYCINIDS.

Vestales Herbst.	nides Boisdu; Erycinidae Westw.; Erycin-
Napææ Hübner.	ites Blanch.-Brullé; Erycinidae Luc; Ery-
Amphipodes Hoffmansegg.	cinidae Herr.-Schneff.
Anopluriform stirps Horsfield.	Heteropodes Wallengr.; Heteropi Guen.
Erycinæ or Polyommata Swains.; Eryci-	Lemoniidae Kirby.

. . . Bright butterflies
 Fluttered their vans, azure and green and gold.
 ARNOLD.—*The Light of Asia.*

Imago. Head rather small; front a little tumid, a little protuberant below; vertex separated from occiput by a partial sulcation in the form of a central pit; antennae consisting of thirty-two joints in our only genus, very slender, thread-like, scaled, about half as long again as the abdomen, the club rather distinct, long and equal, occupying about one-fifth of the antennae; palpi very small and short, compressed and, with few exceptions, only the minute apical joint surpassing the face. Thorax slender, scarcely compressed; posterior angle of mesoscutellum well rounded. Fore

wings with internal nervure distinct, running into the submedian at no great distance from the base; hind wings with a precostal nervure in most (and all North American) genera, the costal nervure ending in the middle of the costal margin, the inner margin hardly channelled.

Fore legs of male greatly aborted, minute, very much shorter than the other legs, entirely without armature, but clothed with long hairs, the tarsi consisting of a single unarmed joint. Middle tibiae longer than the hind pair.

Male abdominal appendages: upper organ consisting of arcuate lateral lobes united mesally through most of their length, but often leaving a notch between them, together forming a hood-like plate, and bearing beneath slender, tapering arms directed at first downward and then backward and somewhat inward. Intermittent organ not so highly developed as in the next subfamily, not apically expanded. Claspers variable in form, not differing much from those of *Lyceninae*, as far as I have seen, but accompanied above by a backward directed, long and slender, basal finger which appears to be quite wanting in *Lyceninae*.

Egg. Echinoid or torate in shape, much broader than high, domed above, the summit with a large, deep, central depression, more or less abrupt; the surface delicately reticulated; the cells either inconspicuous or very deep, the bounding walls sharp, bearing at every angle of reticulation a delicate erect filament, and sending toward, but not to, the centre of each cell less elevated delicate septae.

Caterpillar at birth. Body tapering from in front backward; the head as large as the first segment, by which it is partially covered or to which it is closely attached; body sub-cylindrical; all the segments bearing a dorsal and, sometimes at least, a sub-stigmatal chitinous shield from which arise all the hairs and bristles of the body; these are long, more or less arcuate, minutely spicelliferous; the body is also provided with chitinous annuli arranged longitudinally in the dorsal region; the spiracles of the eighth segment not higher than those of the rest of the body.

The young caterpillars of *Lemoniinae* differ (so far as can be judged from an examination of alcoholic specimens of a single species or two of North American forms, which I owe to the favor of Mr. W. H. Edwards) from those of the *Lyceninae* in the possession of thickened chitinous shields on *all* the segments of the body, from which arise the spicelliferous hairs, seated on papillae. In the species examined (*Chrysobia* and *virgata*) there is a broad and short dorsal shield entirely similar to what we are accustomed to see on the first thoracic segment of *Hesperidae*, but much shorter than the same on *Lyceninae*, broken narrowly at the dorsal line to give better play to the dorsal vessel beneath; there is also a small sub-stigmatal roundish shield from which a cluster of papilla-based hairs arise. The spiracles are situated between these two sets of chitinous shields and are not higher on the eighth abdominal segment than on the others. There is a single subdorsal series of minute annuli on either side, extending the whole length of the body. In form, the structure of the head posteriorly and its relations to the segment behind, there is no distinction from *Lyceninae*, so that the peculiarities of the earliest larval stage lend countenance to that view of the *Lemoniinae* which would regard them as a subfamily of *Lycenidae*.

Mature caterpillar. Head large, as broad as the segment posterior to it, to which it is connected by a membrane which is attached to the summit of the head; the latter deeply emarginate in the middle above and with no posterior declivity, provided with numerous long hairs but never with spines; body nearly equal, sub-cylindrical or sub-ovate, short, being rarely more than three or four times as long as broad, frequently covered with dense pile, and in addition, or in its place, ranged hairs or stiff filaments or fascicles of hairs arranged in longitudinal rows.

Chrysalis. Rather short and plump, well rounded, with few prominences, but frequently enlarged and to a slight degree angulate at the base of the wings, largest on the abdomen; the anterior extremity formed of the large and broad prothorax; the head bent over entirely upon the ventral surface; the prothorax frequently emarginate in the middle anteriorly; the abdomen more or less conical, terminating in a more or less triangular cremaster, which is distinct, projecting, and furnished abundantly with

hooks at its extremity and on the sides; ventral surface of the body flattened but more or less gently arcuate. Either suspended stiffly by the tail or in addition, and nearly always, attached round the middle by a median girth; clothed more or less sparsely with pile and also with long, very infrequent, bristle-like hairs.

Distribution and general characteristics. This lesser of the two subfamilies of *Lycenidae* is almost exclusively restricted to the tropics of America. Not one-twentieth of the known species occur outside these limits, and they are for the most part confined to the tropics of the Old World. A single species is found in Europe, and a few extend north of the tropics in America; only one reaches the borders of New England. No species and probably no genera are common to the Old and the New Worlds, and the larger of the two tribes into which the subfamily is divided, and to which all the United States species belong, is wholly unknown in the Old World.

In the butterflies of this group the anterior tarsi of the males are more atrophied than in the following subfamily, "consisting," says Bates, "of only one or two joints and spineless." Messrs. Godman and Salvin, however, in their review of the mass of material collected for their *Biologia Centrali Americana*, find that in some instances the males have the full number of joints and also the claws; and they even find some diversity in opposite legs of the same individual; but this does not invalidate the statement as one of nearly universal application. These same authors, moreover, have found an additional distinction in these same male fore legs, in that the trochanter is inserted at varying distances from the end of the coxa, leaving a long projecting portion of the coxa beyond the trochanter. The palpi are usually very short, but show considerable variability, and in some are of considerable length. All the species in the adult state, says Bates,

are of smaller size and weaker structure than the average of the *Nymphalidae*, and are distinguished by the tenacity and fragility of the wing-membranes. . . . With very few exceptions, the species are confined to the shades of the great forest which covers the lower levels of nearly the whole of this vast region. I collected myself, 370 species on the banks of the Amazon, or three-fifths of the total number of known species. The family is remarkable for the wonderful diversity of form and colouring which it presents; and the habits of the species are almost equally varied. Some are of very slow, lazy flight, whilst others are excessively rapid in their movements. It may be stated, however, as a universal rule, that their flight is short, never exhibiting the sustained motion which is characteristic of the *Nymphalidae*, *Satyridae*, and other superior families of butterflies. A large number of genera have the habit of settling on the underside of leaves near the ground, extending their wings flat on the leaf. In many genera, on the contrary, the position of the wings in repose is vertical; and a few species settle on the upper surface of leaves with the wings half elevated. As these differences are constant in several large genera, it might be thought that they offered a clue to a natural classification of the family—an object of difficult attainment, if we employ structural characters only; but there are too many exceptions to the rule to render it of any use for this purpose. (*Journ. Linn. soc. Lond., Zool.*, 1x: 369.)

The insects of this group "are of small size and often of very brilliant colours. . . . Some of the species have the hind wings produced into two or more tails, often of very great length, thus resembling the genera *Papilio* and *Thecla*; others in the form of their wings bear a certain resemblance to the *Hipparchiinae*, *Heliconii*, *Nymphalides*, etc. (Westwood, *Introd. classific. ins.*, ii: 257). "More than any other butterflies," says Wallace (*Trans. entom. Soc. Lond.* [2] ii: 262-3), writing of the fauna of the Amazons, these insects

are the inhabitants of the virgin forest, in whose dark recesses many of the rarer and lovelier species are alone to be found. The great mass of the species have a very peculiar habit of invariably settling and reposing on the under surface of leaves with the wings expanded, but there are some striking exceptions to this rule. *Nymphidium* always expands its wings in repose. *Charis* [very closely allied to our *Calephelis*] always exposes itself on the upper surface of leaves. The *Erycinas* fly as strongly and as rapidly as the *Hesperidae*. *Emesis* and *Nymphidium* are also rapid flyers. . . . Most of the other genera are weak but rather active flyers.

De Nicéville states that the Indian species "all have an extremely rapid flight, so fast, indeed, as to be very difficult to follow with the eye, but seldom for more than a few yards, when they settle again."

The eggs of this group are very imperfectly known, but probably will be found to agree in being of a tiarate form, rather higher in proportion to their breadth than in *Lycaninae*, with more or less distinctly reticulate surface, often with short, tapering filaments at the angles of the reticulation. The caterpillars, very few of which are known, are rather more varied in appearance and structure than those of the succeeding group; and, like the perfect insects, are closely allied by structure to the *Lycaninae*, while they often appear to outwardly resemble distantly related groups—particularly the *Hesperidae* and *Morphinae*. They are rarely so strikingly onisciform as the caterpillars of *Lycaninae*, and are sometimes furnished with tufts of short hairs, and even, on the first thoracic segment, with long spines. The first segment of the body is not enormously developed, nor is the head retractile to the extent that is found in the *Lycaninae*. Very little is known of the earlier stages of these insects or of their transformations. The chrysalids closely resemble those of the next subfamily, but are more elongated (as the caterpillars usually are) and remarkable for the long, sometimes very long, and usually very scanty hairs with which they are clothed; they have a less flattened ventral surface than the *Lycaninae*, and are usually much more variegated in color. Some are girt as in the *Lycaninae*, others hang by the tail alone, but in some of these cases, perhaps all, stiffly, so as to hug the surface to which they are attached, and not to hang freely as in the *Nymphalidae*. I add, for the better explanation of the statements in this paragraph, a general review of all that can be learned upon this subject, gleaned from all the sources which I have been able to consult.

Summary of our knowledge of the early stages. So little is known of the transformations of this large subfamily, and so many inaccurate general statements have been made regarding them, that I have thought it would be useful to bring together in a connected form such information as is available, as a starting point for future investigation. The Lemoniinae have been frequently looked upon as an immense reservoir of very incongruous forms, and this has sometimes been an excuse for referring here forms which were aberrant or little understood, as a happy means of ridding the writer of further considering the difficulties in his way. But now that Constant Bar has cleared up some of the errors made by Stoll*, this opinion is no longer justifiable. And, thanks to the recent investigations of the perfect forms by Bates, Godman and Salvin, the integrity of the group can no longer be doubted.

The sources of our information with regard to the early stages of the Lemoniinae are exceedingly scattered. For the European species we have the illustrations of Hübner and Curtis and the statements of many writers, together with specimens now available through Staudinger, whose inclusion of the caterpillars and chrysalids of the European species in his sale catalogues has been of great advantage to the student of butterflies. For the Asiatic species we have only the information given by Moore concerning a single species published in his *Lepidoptera of Ceylon*, and some general statements regarding the eggs, by Doherty, in the *Journal of the Asiatic Society of Bengal* for 1886. For the North American species, we have the admirable and varied illustrations which Edwards has given in his *Butterflies of North America*, concerning the transformations of two of our species, and this gentleman has kindly sent me for examination some specimens which he had preserved, to enable me to make further autoptic study of them. For South American species we have reference first of all to the illustrations long ago published by Stoll, in his continuation of Cramer's *Papillons exotiques*; the two rather brief notices by Constant Bar contained in letters addressed to Boisduval, and published in the *Bulletin of the French entomological society* for 1854 and 1856; and finally a few words only by Bates in his different papers on South American *Lepidoptera*. Nearly all of these publications refer us to the mature caterpillar and chrysalis; Edwards only has figured any of the eggs; the egg of the European species is known only by brief description; those of the Asiatic by the brief notice by Doherty; the caterpillar in its earliest stage just from the egg is known for only two or three species of a single genus from North America, for which we are indebted entirely to Mr. Edwards.

Omitting reference to the Libytheinae, which Bates included in this

* The caterpillar referred by Stoll to *Stalactis euterpe* (pl. I. fig. 4) is said by Bar to belong to *Mechanitis polymnia*, of quite another family. See above, p. 711, note.

group, but which we exclude, the Lemoniinae were divided by Bates into three divisions, one of them, however, including but a single genus or two. In their recent study of the Central American forms, Messrs. Godman and Salvin have shown excellent reasons for modifying this division of Bates by grouping all the Old World forms and a few of the New into one division, which they term Nemeobiinae, regarding it as a subfamily, and all the others into another under the name of Erycininae. This latter division we shall follow in the statements we have now to make.

In the first of these groups, which we should prefer to call a tribe, Nemeobiidi, we have some notices of the transformations of at least four genera, the European and Asiatic species mentioned being two of them, while with one exception the species figured by Stoll are referable to the other two. To take these up in serial order, we have first the European species of the genus *Nemeobius*, *N. lucina*. Of this, all that we are told of the egg is that it is almost globular, smooth, shining and pale green. Of the early stages of the caterpillar absolutely nothing has been published; but the mature larva has very much the form ordinarily familiar to us in the *Lycæninæ*, excepting that it is more elongated and has a larger head; so far as can be judged from blown specimens, there is no such substigmatal fold as is seen conspicuously in most of the *Lycæninæ*, nor any dorsal crest, but a cross section of the body would seem to be best described as a flattened cylinder. The head, indeed, is clothed with long and rather coarse hairs nearly to the summit, and the membrane connecting the skull with the harder part of the first thoracic segment is considerably shorter than the head, showing that it can be withdrawn within the first thoracic segment or covered by its integument to but a very slight degree; the skull has, however, no downward deflection at its posterior edge, which is strongly emarginate in the middle, as in the head of the *Lycæninæ*. The body is clothed with very fine, short and downy hairs, and also with some coarse, spiculiferous bristles supported by small papillae, which are slightly clustered in transverse rows across the middle of the segments, and are accompanied by irregularly scattered, chitinous annuli of the same size as the papillae in their immediate vicinity; the first thoracic segment has a dorsal shield of distinct but not very pronounced character; the spiracles are very small, those on the seventh and eighth abdominal segments on a line with the rest; the legs and prolegs are moderately short. The caterpillar is said to live "très cachée." The chrysalis has a form which differs from the type of the *Lycæninæ* in scarcely anything, excepting the posterior termination of the abdomen. The prothorax is very large; the head is completely ventral; the general form of the body is a little more elongated than in most *Lycæninæ*; the metanotum is pretty large, but the abdomen tapers posteriorly with considerable regularity to a point, this point being the cremaster, which is triangular, its sides continuing the

course of the sides of the abdomen, and is covered on the sides, at the tip, and even on the upper edge, with very long hooks, so that here it does not at all agree with the characteristic form of the *Lycæniinae*; the body is covered sparsely with very short pile, shorter than that of the caterpillar, and with the very infrequent, long, spiculiferous bristles seen on the larva, but here arranged with no regularity whatever.

The next one of the *Lemoniinae* whose transformations are known is an Asiatic species of *Abisara*, *A. prunosa*. The illustrations on Pl. 33 of Moore's work show us the caterpillar, seen on a side view, as subonisciform, with a head bearing much the same relation to the body as we have seen in *Nemeobius*, moderately long legs and fusiform body, and covered with very long hairs, apparently not more than six or eight to a segment; the description says "numerous dorsal and lateral short fine hairs," which we presume means a pile in addition to the long hairs represented on the plate. The chrysalis also is fusiform, as seen from a top view, and covered sparsely with long hairs, but is poorly drawn, so that one can hardly venture to say more, excepting that there is no indication that the head can be seen, and the termination of the abdomen is apparently almost precisely like that of *Nemeobius*, excepting that it is a little more attenuated.

The only other information we have regarding the Asiatic species is a statement of Doherty that the eggs of a few genera he has examined (he does not specify further) are "not so high as wide, smooth, granulate or prickly, not reticulate nor radiate," that is ribbed.

We turn now to Stoll, whose illustration of *Euselasia crotopus* (we use the terminology of Kirby) is given in figure 7 of his sixth plate. In this the caterpillar is represented as strictly onisciform, very short, covered densely with hairs rather longer than a segment, including a lateral fringe along the base of the body, with a mat of brilliantly covered hairs covering the first two thoracic segments, accompanied by a pair of long, straight, tapering appendages, as long as the width of the body, which Stoll calls spines, but which we should rather regard as in greater probability stiff filaments; the head is comparatively large, but apparently not more than half the width of the body. The chrysalis is nearly of the same shape as the caterpillar, largest just next the basal wing tubercles, tapering more rapidly in front than behind, broadly and equally rounded at each end, and covered with pile shorter than that of the caterpillar; further detail cannot be seen. Another species of *Euselasia*, *E. gelon*, figured by Stoll, but unfortunately only in the perfect stage, is said by Bar to be nocturnal in habits, processional, the caterpillars following one another in a single rank; it is covered with pile (velue), and "wholly resembles a caterpillar of a small *Bombyx*." The chrysalis somewhat resembles that of *Thecla*.

Two species of *Helicopsis*, *endymion* and *cupido*, are figured by Stoll, and resemble each other considerably. The caterpillar of *endymion* is represented as having a head covered with a dense red pile, besides long white hairs, the red pile giving it, in the rather coarse illustration, a size apparently much greater than reality; that is, of about the same breadth as the body, and larger than the segment next succeeding; if this is accurately represented, it would be very different from other *Lemoniinae*; but the similar character of the anterior extremity of the chrysalis, which can hardly be thought to be other than tapering at this point, leads us to believe that in both the representation of the pile obscures the actual outline of the hard parts. The body of the caterpillar is apparently nearly cylindrical, but depressed, feebly fusiform, and a little more than three times as long as broad, with frequent long white hairs as long as the body. The chrysalis is again of a similar shape and longer in proportion to its width than any other chrysalis of the *Lemoniinae*, being not greatly less than four times as long as broad. It is nearly uniform, but tapers considerably toward the tail, where it shows no sign of being constructed otherwise than in other *Lemoniinae*. The body is covered with long white hairs, as in the caterpillar, together with the red pile already referred to at the anterior extremity, which is again repeated at the tail. The chrysalis is represented as lying upon the top of a leaf, fully exposed.

The caterpillar of *H. cupido* is very similar to the last, but the head is represented as itself red without the pile of the other species and yet is nearly as large as that, being indeed narrower than the body but broader than the segments immediately posterior to it. It should be remarked, however, that the head of the cast-off skin at pupation is not at all larger than the front segment of the caterpillar; now as this is seen in full face, we must believe that it represents more correctly the actual relation of the head to the body. The body, covered with the same kind of pile as the other species, does not differ from it sufficiently to call for comment, excepting that it is longer and slenderer and more uniform, being about four times as long as broad. The chrysalis differs considerably from that of *endymion*, being represented with the ordinary form of a noctuid moth, largest in the middle, bluntly rounded in front, tapering to a point posteriorly and about three and a half times longer than broad. In this instance it is represented from the ventral side, as is seen by the attempt to indicate the position of the legs; this has doubtless been done in order to show that in the chrysalis as in the caterpillar the head is red, the head being entirely upon the ventral surface, a point which could not be shown had the chrysalis been placed in the opposite position; the net work of pale lines which are seen at the edge is simply meant to represent the long pale hairs characteristic of this genus both in the larva and chrysalis state. The position of the cast-off skin with the rude painting of the leaf

have led subsequent writers to state that these species undergo their transformations in a rolled-up leaf, but there is no warrant whatever for such a statement, the chrysalis being represented in both cases as entirely exposed to view lying next the midrib of the leaf; the leaf is, indeed, curled slightly at the edge, but this is either for supposed artistic effect, or else it is meant to indicate that the caterpillar turns the leaf into a sort of trough for partial concealment; but, if so, the trough is slight and wide open, and there is not the slightest semblance of a cocoon in the transformation, nor is anything of the sort stated in the text, but only that it is attached by the tail and by a median girth.

These are all the data we have for the transformations of the Nemeobiidi. The remainder relate to the Lemoniidi, and are in fewer cases illustrated. The first refers to a species of *Limnas*, which Bar states is crepuscular in the imago state; his only mention of the transformations is that they are attached to twigs by their tail alone, but not free, lying along the twig that supports them; this at least I take to be the meaning of his expression ("soudées le long de quelques rameaux"), since he contrasts it with the fixedness of the chrysalis in the genus *Thecla*, and the more so as he uses the same expression with regard to the chrysalis of *Aneyluris melibocus*, which he elsewhere tells us is suspended head downward without any transverse girth.

Of this latter species he gives a fuller account, and says the caterpillar resembles *Liparis* but is proportionally broader; that the sides are furnished with tubercles or solid points of unequal length placed in two rows, the upper row being composed of six points placed on the hinder segments, and the lower row of four shorter points similarly placed; pale fulvous hairs cover the side of the entire body, concealing all the parts below them, forming rather long tufts; the dorsal portion is fulvous and covered with large velvety black spots formed of pile, in the midst of which one may distinguish longer pure white hairs, cottony at the tip; the size of the head is not stated. The chrysalis resembles that of a *Thecla*; the head is stated to be provided with two short earlets directed backwards; by these are evidently meant the prothoracic spiracles, and he must therefore have confounded the head and prothoracic segment; his statement therefore indicates that the head is entirely concealed on the under side of the body; especially as he adds that this "head" is emarginate in the middle, which is exactly the case with the prothorax in *Nemeobius*, and indeed in many *Lyceninae*, and is doubtless a common character of *Lycenidae*. The segments are said to be supplied with the same tubercles as the caterpillar, the general color being whitish with the reproduction of the spots found in the caterpillar.

The chrysalis of *Diorhina*, closely allied to the last, is said by Bar to hang in precisely the same way. So, too, Bates states that *Emesis man-*

dana has been bred by him and is suspended by the tail as in *Stalachtis*, another genus of this tribe, which he elsewhere speaks of as "not flattened beneath, and secured rigidly by the tail in an inclined position without girding."

Stoll', indeed, figures the transformations of *Stalachtis calliope*; he represents the caterpillar as cylindrical and slightly depressed, of uniform width throughout, about three and a half times longer than broad; the head is hardly more than half as wide as the body, rounded and hairy; the first thoracic segment bears a semilunate shield as wide as the head, and a similar though smaller shield is found upon the last segment, with black points on the intermediate ones; the segments are distinctly moniliform and apparently are elevated at the base of slender hairs, longer than the segments, which appear to be clustered to a certain extent in fascicles and which are accompanied, apparently at the substigmatal fold, by a stouter bristle, as long as the width of the body on each segment; besides this the body is covered with a shorter pile. The chrysalis is represented without attachment, but in a perpendicular position head downward, and is described by Stoll' as being attached to a leaf stem by its hinder extremity only by means of a stiff bristle (poil roide), "hanging perpendicularly with its head toward the earth, like the spiny caterpillars of the tetrapod butterflies"; the chrysalis has a form very similar, indeed, to that of *Nemobius*, similar also in its markings and in being very sparsely covered with long hairs; a dorsal view is given and the anterior extremity is apparently terminated by the prothorax.

Finally, we have the far more satisfactory illustration of *Chrysobia*, in the figures given by Edwards, and here we are also able to draw upon our knowledge of the species from specimens kindly sent us for examination by Mr. Edwards. The eggs of two species are figured and described by him, and these as well as those of the third, *L. virgulti*, he has kindly permitted me to see. They are flattened spheroids, broadly domed above, delicately and finely reticulated and bear at each angle of the sharp hexagonal reticulation a delicate filament no longer than the width of the cells. In nais these filaments are more pointed than in *palmerii*, but do not otherwise essentially differ, though figured and described differently by Edwards; in *virgulti* they are as in nais. Such reticulation is common in the *Lycacninae*, but the cells of the reticulation have apparently one distinguishing quality in *Chrysobia*, which is that from the walls of the cell toward, but hardly to, the centre run low, sharp septae, reminding one very strikingly of the similar feature in coral polyps; very probably this may prove true of all *Lemoniinae*; while, as far as I have seen, in the eggs of the *Lycacninae* there is no such radiate arrangement of the walls, though in some, especially in the *Lycacnidi*, the centre of the floor of the cell may be thickened and the thickening run in a radiate direction toward the walls of the

cell without reaching them. The micropyle rosette, which I have seen only in nais, is a deep infundibuliform pit at the very centre of which is a secondary minute puncture. That of *palmerii* is figured by Edwards as forming a very broad, crateriform, abrupt pit. The caterpillars at birth have been excellently figured by Mr. Edwards, but as I have already given the characteristics observed in specimens they need not be repeated here. Mr. Edwards has kindly sent me a caterpillar of *Chrysobia ver-gulti* in its second stage, which is the only one of the later stages of the caterpillar I have seen in this tribe; but Mr. Edwards figures that of *Chrysobia nais* in an excellent manner. In this it appears that the caterpillar is strictly cylindrical, nearly equal, tapers very gently from the middle of the body backward, more rapidly at the extreme tip, scarcely tapers forwards, and has somewhat abbreviated legs and prolegs. The head, which is constructed precisely as I have described that of *Nemeobius*, is relatively larger, being about three-fourths the greatest width of the body, and therefore not greatly narrower than the segment immediately posterior to it; according to Edwards, it is "partly covered" by this but not retractile; the posterior border is dorsally emarginate as in *Nemeobius*, and long hairs are found upon it up to the summit. The body is covered with longitudinal rows of spreading fascicles of short hairs, two upon either side besides a stigmatal series of longer hairs; some long arching hairs are also found at each extremity of the body, and the first thoracic segment is covered with a divided dorsal shield not conspicuously more corneous than the other parts of the body, bristling with hairs. The chrysalis has a shape precisely like that of *Nemeobius*, excepting in being slightly longer, and like it is attached both by the tail and by a girdle round the middle; the ventral surface is nearly flat, with a sinuate curve; the body is sparsely covered with not very long hairs and the eremaster, while completely independent and protruding, is not pointed but apically truncate.

We think that it will appear very clearly from this review that the structure of the early stages and the transformations of the *Lemoniinae* are not widely different from those of the *Lycaeninae*, by no means sufficiently so to support the separation of the two groups as distinct families. There is, indeed, no more difficulty in harmonizing the somewhat curious differences one sees in the larval and pupal forms of the *Lemoniinae* than there is in those of *Lycaeninae*; there is no more difficulty in retaining any one of them within the group than there is in retaining among the *Lycaeninae* such forms as *Spalgis*, figured by Moore, or *Curetis*, figured by Horsfield, or our own *Fenisecca*. On the other hand the subdivision of the subfamily suggested by Godman and Salvin would seem to be borne out by the characteristics of the early stages. For it would appear that we may even be able to separate these two groups by characters drawn from the early stages. It

would seem as if in the Nemeobiidi the eggs might be characterized by being nearly smooth with slight reticulation; the caterpillars as densely clothed with pile, conspicuously so in certain definite regions, especially at the two extremities of the body; and the chrysalids would appear to be always girt round the middle; while on the other hand in the Lemoniidi, as far as we yet know, the eggs are deeply reticulate and filamentous, the caterpillars are provided with fascicles of hairs definitely arranged in longitudinal series along the body, giving them the appearance, as Bar expresses it, of a *Liparis*; while the chrysalis is usually not girt around the middle, but supported stiffly by the tail alone, the only exception thus far known being in the species of *Chrysobia* figured by Edwards.

The food plants of several of the Nemeobiidi are known and they are very various, belonging to all the main divisions of exogenous plants excepting the gymnosperms. *Nemeobius* feeds on *Rumex* (Polygoniaceae) and perhaps *Primula* (Primulaceae); *Abisara* on *Arlisia* (Myrsinaceae); *Helicopsis endymion* on *Passiflorae* and *H. cupido* on *Rutaceae*. Of the Lemoniidi we know the food plant of *Lemonias* only, which is *Prosopis* (Leguminosae). The Gamopetalae seem to be the favorites.

CALEPHELIS GROTE AND ROBINSON.

Calephelis Grote-Rob., Trans. Am. ent. soc., ii: 310 (1869).

Type.—*Papilio caeneus* Linn.

Ja, ja, wir sind im Himmel, süßes Lieb,
Siehst du die Blumen, die dort unten spielen,
Die Schmetterlinge, die dazwischen flattern,
Und, neckend, bunten Diamantenstaub
Den armen Blümlein in die Augen werfen?

HEINE.—*Almansor*.

... every thing that grows
Holds in perfection but a little moment.

SHAKESPEARE.—*Sonnet*.

Imago (54:7). Head quite small, densely tufted with a nearly uniform pile of rather short, curving hairs. Front a little full, especially below, where it is slightly protuberant and surpasses the front of the eyes, while in the other parts it only equals them; scarcely half as high again as broad, fully as broad as the eyes on a front view, the sides slightly approaching each other below; upper border well curved in front of the antennae, its edge a little rounded off, in the middle projecting strongly and narrowly between the antennal pits, where it is not arched transversely; lower border broadly and fully rounded; from the middle of a line drawn between the upper posterior angles of the eyes, a moderately deep sulcation runs to each antenna, separating the otherwise scarcely elevated centre of the vertex from the slight tuberculous swellings behind each antenna, which in their turn are separated by deeper sulcations from the margin of the eye; the central sulcations cross each other, passing a little behind a line connecting the eyes, and, by their union, forming a sort of pit. Eyes neither large nor full, naked. Antennae inserted with the posterior portion of their base in the middle of the summit, in distinct pits, separated by a slight but perfectly marked wall, not more than equalling the diameter of the stalk; nearly half as long

again as the abdomen, composed of thirty-two joints, of which twelve form the cylindrical, depressed club, which is very gradually thickened, less than twice the breadth of the stalk, about five times as long as broad, terminating in a very bluntly rounded apex, in which three or four joints participate. Palpi very small, slight and short, not more than equalling the length of the eye, the last joint not half the length of the penultimate, all the joints but the last clothed beneath with a mass of long, projecting scales, accompanied by a few long or scale-like hairs; the last joint partakes of the same character to a very slight degree.

Patagia long but not very narrow, arched slightly and somewhat tumid, the outer border a little hollowed near the middle, leaving the posterior lobe—or the apical half of the whole piece—about three-quarters the width of the base and equal, the apex broadly rounded.

Fore wings (39:10) considerably more than half as long again as broad, the costal margin very slightly curved at base and tip, nearly straight along the middle, the apical angle slightly less than a right angle, scarcely rounded, sometimes subfalcate; outer margin nearly straight, scarcely rounded above the middle of the lower median interspace, below that receding a very little, the inner border straight, the outer angle scarcely rounded. Costal nervure terminating a very little before the tip of the cell; subcostal nervure with three superior branches, the third forking somewhat beyond the tip of the cell; internal nervure short and running into the submedian close to the base.

Hind wings with the costal margin abruptly shouldered and slightly plicated at the base, beyond straight, the apical portion curving a little; outer border pretty well rounded, especially above, the upper angle rather abrupt but rounded off a little, the inner border slightly convex at first, the apical four-fifths slightly excised, the outer angle rather abrupt but rounded off a little. Precostal nervure very feeble, running only from the bending of the costal nervure half way to the margin, in the direction of the basal part of the costal nervure. Cell half the length of the wing, and three and one-half times longer than broad. Submedian nervure terminating on the outer border, near the anal angle; internal nervure terminating a little beyond the middle of the inner margin.

Fore legs long, slender and cylindrical (♀), or exceedingly short and minute, but comparatively stout, and aborted (♂); clothed like the other legs (♀), or abundantly furnished with long, recumbent scales and hairs, the trochanter attached to the tip of the coxa (♂); fore tibiae three-fifths (♀) or one-fourth (♂) the length of the hind tibiae; fore tarsi more than four-fifths (♀), or about two-fifths (♂) the length of the tibiae; either consisting of a single, rather stout joint, rounded at the tip, and, like the tibiae, entirely without armature (♂), or agreeing almost entirely in character with the other legs, although the terminal joint is unscaled (but apically armed like the others), and the spines are almost entirely absent from the whole tarsus, although the spurs are very well developed (♀). Middle tibiae a little longer than the hind pair, armed with but very few scattered minute spines, and furnished at tip with a pair of pretty short, rather slender spurs, clothed with scales at their base. First joint of tarsi nearly equal to the three following joints combined, while they diminish in regular ratio, the fifth equalling the third; furnished beneath with quite long and slender, not very frequent spines, mostly confined to an outer row on either side, the apical spines of each joint longer than the others, and a little curving; claws very small and pretty slender, compressed, tapering, finely pointed, rather strongly and regularly curved; paronychial double, each lobe as long as the claw, equal, curving a little, the upper tapering to a fine point, and running close beside the claw, the lower equal and blunt-tipped; pulvilli very small, circular, sessile.

Male abdominal appendages with the lateral alations of the upper organ united above by about half their length, leaving a slender notch between them; distal half of the elbowed inferior arm arcuate, curving upward, reaching the rounded hind border of the alation. Clasps with the basal half bullate, the outer slender and cylindrical, the basal superior finger half as long as the clasps, very slender, aculeate, setose.

This genus of naked-eyed *Lemoniinae* is almost peculiar to North America and the only one yet known to occur in the eastern United States north of Florida. Its home is in north tropical continental America where not a few species are found; it extends, however, into the warmer parts of the temperate zone and three or four species are found in the southern half of the United States; one of them has long been known in the Carolinian region, two or more are found in the arid parts of the west, and one covers a wide, though as yet unknown, extent of the country and has been found on a few occasions in our northern states. The northern species has not yet been found within the limits of New England, although first discovered not far from its boundaries. It probably ranges to Brazil.

The butterflies of this group comprise some of the smaller *Lemoniinae*; the wings are rather regularly rounded and of a dull dark red, darker above than beneath, traversed by slender, parallel, arcuate series of short blackish dashes; a marginal plumbeous or steel colored stripe, a similar but tortuous one in the middle of the outer half of the wing and between these two a series of blackish dots. The only recollection I have of their flight as seen in my boyhood is that they did not rise more than a foot or two above the ground.

Their transformations are altogether unknown.

EXCURSUS XXV.—THE NAMES OF BUTTERFLIES.

Vous-mêmes dans ces lieux vous serez appelés,
 Vous, le dernier degré de cette grande échelle,
 Vous, insectes sans nombre, ou volants ou sans aile,
 Qui rampez dans les champs, sucez les arbrisseaux,
 Tourbillonnez dans les air, ou jouez sur les eaux
 Là je place le ver, la nymphe, la chenille;
 Son fils, beau parvenu, honteux de sa famille
 L'insecte de tout rang et de toutes couleurs.
 L'habitant de la fange, et les hôtes des fleurs.

DE LILLE.—*L'Homme des Champs.*

WHEN in the preparation of the present work I found myself compelled by my study of the fauna to make use of a scientific terminology very different from that then in ordinary use, it seemed as if it might be desirable that at least our commoner species should have English names, which might in time become settled and then endure through all possible variations of scientific terminology. I noticed that in all the popular British works upon butterflies, an English name was almost invariably given, and that the names adopted by different authors did not always agree. It appeared, therefore, to be probable that many of them were manufactured for the occasion. Some were extremely pretty, others appeared forced. I noticed, further, that for the similar convenience of agriculturists

an English name, often bungling and difficult to remember, a translation perhaps of an awkward scientific name, was given to insects treated of in economical reports; and, further, that Gosse, an Englishman who came to this country in his youth and wrote very interestingly of our animals, almost invariably applied a name, apparently of his own coining, to the butterflies with which he here came in contact. I therefore made an attempt to introduce such names into our nomenclature, where they had not already been given, endeavoring to adopt from the English such generic terms as fritillary, hair-streak, etc., for similar butterflies of our own country, and to coin appropriate names where required. I published a list of this sort in the first volume of *Psyche*, which, strangely enough, met with most violent opposition, an opposition which appeared to me to be entirely unreasonable and certainly out of all proportion to the adjudged crime.

Accordingly in the present work I have again attempted to collate all the names that I could find that had been given to our different butterflies and to select from among them that one which seemed most worthy of permanence, as my contribution toward a popular terminology. Of course in this case precedence is of no consequence, and local names applicable to another continent can scarcely be used. But I have not hesitated to devise names for such as have not already received them, in the hope that they may sometime be favorably received. Exception was made to my first list on the ground that such names should have a real popular value and origin; and this objection is unquestionably valid. But that attempt and the present are only efforts at the introduction of names which may hereafter become as strictly popular, in a technical sense, as those which have been given to certain common butterflies in other parts of the world. They must once have been named by some one and the practice is common among ornithologists; only recently Mr. Selater was complimented in the columns of *Nature* for his success and good judgment in this matter. I have further support in the fact that one finds among the early authors on the continent of Europe many attempts of this same kind, where common names have been applied which may or may not have come down to us at the present time. Thus taking up the other day the old work of Sepp on Dutch butterflies, I found such names as "konings-mantel" (a curious variation from the German trauermantel) given to *antiopa*, "distelvink" to *cardui*, "nommer-vlinder" to *atalanta*, and to others not found in this country such odd names as "de eike page" and "hooi-beestje." I should be sorry if old Sepp had not taken this liberty. This is my warrant and my only warrant for the introduction of such names in the present work. It seems to me that they will possibly serve a useful purpose, and certainly they can do no one any harm. They can be simply ignored. They will only survive if fitted to do so.

One examining for the first time the scientific terminology of butterflies would be interested at seeing how largely the names, and especially the early ones, had been bestowed by authors who had received a classical education, and how extensively the Greek mythology figured in the nomenclature of these creatures. The many forms of the name of Venus in particular would strike one. Much of this is certainly due to the example set by the first great nomenclator of zoology, Linné, who applied also the names of Greek heroes in the Trojan war to a very large number of swallow tail butterflies, and his example has been followed by lepidopterologists down to the present day. A few notable exceptions will be found in later times when names of old Scandinavian mythical heroes were introduced into the nomenclature of European butterflies; and in our own country Harris, when he found so large a number of skippers unnamed, bethought himself of a new device, which was the use of the names of Indian chiefs of greater or less historic fame which have come down to us, and his example, first followed by Edwards and myself, has been taken up by nearly all subsequent writers, so that the bulk of the specific names of our Pamphilids are now drawn from those of the dusky red aborigines of our country.

As to the very word "butterfly" itself, there has been much written, but, strangely, as it seems to me, the persons best qualified by their philological learning are least assured concerning the derivation of the name. Skat and Murray can hardly be entomologists. "It has amused many to devise guesses to explain the name," says Skat. Mr. Frederick Clarkson, in the Canadian entomologist (xvii: 44) thinks there is good reason to believe that the root-meaning of the word "dates back to early Egyptian history, and as a hieroglyphic it is synonymous as representing the qualities of completeness and perfection which characterize the soul." All of which I in my ignorance judge to be humbug. One distrusts much of the reasoning drawn from hieroglyphs, for it would seem in general that almost any meaning can be drawn from them by dilettanteism if only sufficient ingenuity is put in. An English writer, whose name I do not now recall (was it Miss Mitford?), has strenuously upheld the idea that a butterfly was simply a *better* sort of fly, laughing to scorn the common notion, which seems to me, as I think it must to all entomologists, to be unquestionably the correct one, that the word is simply an expressive name given to the commonest form of butterfly that is found in Europe, where the name arose, namely, the butterflies of the genus *Eurymus*, which are ordinarily of much the same kind of yellow that one finds on the buttercup, whence the name of both. One feels the greater confidence in this because the term is applied in so many different languages in much the same way. In Anglo-Saxon, it is *butter-flæge*, which is simply butterfly; while some of the variations of this term in other languages are the Dutch

botervlieg, earlier botervlieghe, the German butterfliege, and the earlier German form, buttervogel.* Other variations of the same name will appear in the poetical quotations from different languages which we have scattered throughout the present work. Murray in his New English dictionary gives various extracts showing the early use of this name, the earliest in the Anglo-Saxon being as far back as 1000 by Aelfric. Chaucer gives it in another form: "swich talkyng is nat worth a boterflye."

CALEPHELIS BOREALIS.—The large metal-mark.

[The large metal-mark (Grote); the steel speck (Scudder).]

Nymphidia borealis Grote-Rob., Ann. lye. nat. hist. N. Y., vii: 351-353 (1866).

Charis (Calephelis) borealis Grote-Rob., Trans. Amer. ent. soc., ii: 310 (1869).

Charis borealis Kirby, Syn. catal. Lep., 319 (1871).

Polystictis borealis Scudd., Syst. rev. Am. univ., 29 (1872).

Calephelis borealis Grote, Can. ent., v: 144 (1873);—French, Butt. east. U. S., 253 (1886).

Charis laeerna? Godm.-Salv., Biol. centr. amer., Rhop., i: 430-431 (1886).

Nymphidia geda Boisdu., Mss.

Figured by Glover, Ill. N. A. Lep., pl. II fig. 3 (ined.).

Atoms of color thou hast called to life,
(We name them butterflies), float lazily
On clover swings, their drop of honey made
By thee, dear queen, already for their need.

MARY BUTTS.—A Quest.

A rich mantle he did wear
Made of tinsel gossamer,
Bestarred over with a few
Diamond drops of morning dew.

MENNIS AND SMITH.—King Oberon's Apparel.

Imago (6: 2; 14: 16). Head covered behind with blackish fuliginous scales; behind the eyes, excepting above, with a rather broad belt of saffron scales; above with blackish fuliginous scales and hairs, with scattered reddish saffron ones, especially in a little patch behind the base of each antenna; lower portion of front saffron, tinged strongly with reddish above. Antennae blackish, darkest above, slightly and minutely specked with reddish, annulated rather narrowly at the base of each joint of the stem, particularly above, with white, the apical two joints of the club dull reddish luteous. Palpi saffron, pale in the upper portion of the sides, the apical joint blackish, particularly above. Tongue very pale luteous, fuscous at the very base.

Thorax above together with the patagia, covered with blackish fuliginous and some paler scales and hairs, beneath saffron. Legs saffron colored, the tarsi dusky, the apex of the tibiae and tarsal joints infuscated; spines dull luteous; claws dark luteous.

Wings above, dull brownish yellow, having a cinnamonous tinge. In great measure concealed by a heavy sprinkling of brownish and blackish fuliginous scales, the latter often collected into obscure, transverse stripes and the wings consequently presenting a grimy and rusty appearance. On the fore wings three of these stripes are equidistant from one another within the cell, and reach from the subcostal to the submedian nervure; another marks the outer limit of the cell; while a larger median one crosses the

* Compare our own ladybird for Coccinella, as in the common distich, which ran differently in my childhood from what is set down in the books. I was taught to say:—

Ladybird, ladybird, fly away home,
Your house is on fire and your children will
roam.

anterior half of the wing at one-third the distance from the tip of the cell to the outer margin, its general direction at right angles to the costal border, bent at more than a right angle in the upper median interspace and terminates a little beyond the middle of the inner border; between the median stripe and the outer border, but nearer the former and, excepting in the most of the subcostal area, parallel to its outer border, is an irregularly sinuous thread of steel colored scales, slightly intensified by an external lining of blackish fuliginous scales; following it from behind forwards, it suddenly turns, in the middle of the lower subcostal interspace, forwards and outwards, afterwards curving forwards and losing itself before attaining the costal margin; there is a submarginal straight thread of similar scales edged obscurely on either side with brownish and blackish fuliginous scales, distant by half an interspace from the outer border and followed within, at the distance of an interspace from the outer border, by a series of small black spots in the middle of each interspace that in the medio-submedian double; besides these markings the wing is greatly but not regularly obscured by dusky scales, the brightest tints being found near the outer portion of the cell and the outer border of the wing; fringe brownish fuscous, a little paler on the anterior and posterior part of the wing and with a pale line just before the middle of the fringe. A median slenderer, blackish stripe crosses the hind wings; the general direction of its anterior half is at right angles to that of its lower half, bent in the middle of the upper median interspace at about two-thirds the distance from the base to the outer border of the wings; the upper half is nearly, though irregularly continuous, excepting in the upper subcostal interspace where it is removed outward to a considerable distance; the lower half consists of a series of short lines each crossing an interspace, subparallel and removed consecutively farther inwards. Within this median band the wing is nearly uniformly infuscated and to a greater extent than outside of it; the dusky scales are, however, clustered to some extent into short, slightly curving, blackish, transverse lines, the most conspicuous of which is the one which marks the outer limit of the cell. Beyond the mesial stripe and subparallel to it, at about one-third the distance to the outer border, is a continuous sinuous thread of steel colored scales, bordered on either side, but especially externally, with blackish fuliginous scales; there is a similar but regularly curving steel colored, submarginal thread, similarly bordered but with rather lighter scales; between the two, but nearer the latter, is a curving row of small blackish spots, one in each interspace, excepting the medio-submedian where there are two; fringe as on fore wings.

Beneath of a rather dark and pale orange, paler and duller next the base, marked with transverse black lines and dots and transverse series of steel colored spots. *Fore wings* with four series of transverse black lines; the first, close to the base, consists of only two short streaks, one in the cell and the other in the medio-submedian interspace, about half way between the base of the wing and the origin of the first median nervule; the second consists of longer and nearly continuous streaks similarly situated, but at the first divarication of the median; the third twice as distant from the second above as below, commences by the black streak which limits the cell apically and is continued below by three little spots in the interspaces; there is also a pair of minute dots in the cell, one above, the other midway between the second and third mentioned series; the fourth consists of an interrupted, transverse row of narrow bars, subparallel to the third, crossing the whole wing; in the subcosto-median and next to the lowest subcostal interspaces, it is about midway between the tip of the cell and the outer border; in the lowest subcostal it is removed considerably inwards; in the upper median interspace it is scarcely within the dash of the interspace above, and in the interspaces below it has a general direction parallel to the hinder part of the outer border; in the interspaces next the costal border on the outer half of the wing there are also minute short dashes, directed backward and outward; next the fourth transverse series mentioned above there is a transverse row of rather large, nearly continuous, pretty broad, steel colored lunules edged narrowly with blackish. They are subparallel to the outer border and lie nearer to it than to the outer extremity of the cell; the series is slightly bent at the middle median nervule and either half has a

very slight curve, its concavity outwards; the upper half is the most nearly continuous; there is a narrow, straight, submarginal stripe of steel colored scales, distant by half an interspace's width from the outer border, edged with a few discontinuous blackish scales on the inner side and occasionally a few on the outer side; following it inwardly is a series of black dots like those of the upper surface; fringe as above. *Hind wings* with four series of black streaks like those above and similarly situated, the first indistinct; the fourth commences in the costo-subcostal interspace, just beneath the tip of the costal, crosses the upper subcostal interspace by a full interspace's width further outward, resumes its former course in crossing the lower subcostal and again leaps to the same extent outwardly at the subcosto-median and upper median interspaces, after which it again returns to its former direction and continues interruptedly but with a uniform direction to the middle of the inner border; there is a transverse series of moderately slender, interruptedly continuous, steel colored lunules, scarcely bordered with black, one in each interspace, in the same relative position as the transverse series of lunules in the fore wing; as there also, the series is bent at the middle median nervule and the general direction of either half is a slight curve, its concavity outwards; a submarginal steel colored stripe, followed inwardly by a row of black dots, just as in the fore wing; fringe as above.

Abdomen above blackish mingled with grayish scales, below bright saffron. Male abdominal appendages (34: 10, 11) with the lateral arms of the upper organ bent strongly, the basal portion stout and swollen, the distal tapering with great regularity to a fine point, bent slightly upward. Apical half of clasps bent about the middle so as to be directed straight backward, instead of slightly upward and inward as previously, the tip blunt and rounded; basal finger about as slender as the distal portion of the lateral arm above, but bluntly pointed.

Measurements in millimetres. Length of tongue, 6 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....		13.25				
antennae.....		7.25				
hind tibiae and tarsi..		1.55				
fore tibiae and tarsi..		4.5				

Described from 2 ♂.

Secondary sexual distinctions. On the upper surface of the wings I have found, in the male and not in the female, a very few untoothed scales so closely resembling others in similar situations in the lower Nymphalidae that I think it probable they are androconia (46: 17); they are of a quadrangular form, scarcely enlarging apically, three times as long as broad, the apex truncate with rounded angles, the basal lobes distinct, broad, well rounded; they measure .15 mm. in length or are slightly larger than the normal scales.

This very rare butterfly has only been recorded from two or three localities, but these are so widely distant that we may hope for its detection at any point within the limits marked on our map (22: 8). It was first discovered by Messrs. Grote and Robinson in Coldenham, Orange Co., N. Y., and has since been taken in Michigan (Austin in coll. Univ. Mich.), the township of Ohio, Ill. (Morrison), New Jersey (Edwards) and Coalburgh, W. Va., a single specimen or two (Edwards). I have also seen specimens from Tehuantepec (Sumichrast, Mus. Bost. soc. nat. hist.) which seems indistinguishable and which in all probability is Godman and Salvin's *laverna*, an uncharacterized species, which they report from Mexico (Presidio), Honduras, Panama (Volcan de Chiriqui,

Calobre, Lion Hill) Columbia, Venezuela and Brazil. If it be the same our species has certainly a wide range, and in any event is to be looked for in New Mexico, eastern Colorado, Kansas and Nebraska, or indeed in almost any part of the transmississippian district. The New York specimens were taken in July, the Illinois specimens May 7, so that by comparison with the southern species, *C. caeneus**, it is probably polygentic: but beyond this we have no knowledge whatsoever of its history.

Every fact concerning the life, habits and distribution of this butterfly is of importance, and all the more desirable since this is the only representative of the subfamily in the northern United States. It would be especially interesting to know in what way the chrysalis is suspended. The allied species, *P. caeneus*, is so common in the south that the determination of all generic features in the early stages ought not to be difficult. This is the most important lacuna in our knowledge of the transformations of North American butterflies that remains to be filled.

LIST OF ILLUSTRATIONS.—*CALEPHELIS BOREALIS*.

General.

Pl. 22, fig. 8. Distribution in North America.

Imago.

Pl. 6, fig. 2. Male, both surfaces.

14: 16. The same.

34: 10, 11. Male abdominal appendages.

39: 10. Neuration.

46: 17. Scale of male.

54: 7. Side view of head and appendages enlarged, with details of leg structure.

SUBFAMILY LYCAENINAE.

Plebeii Cuvier.

Ephori+Clives Herbst; Ephori Scudd.

Agrodiacti Hübner.

Vermiform stirps Horsf.

Lycaenidae Steph.; Lycaenites Blanch.

Brullé; Lycaenides Bois.; Lycaenoidae

Wallengr.; Lycaenitae Luc.; Lycaenina

Herr.-Schaeff.; Lycénides + Euménides

Boisd.; Lycaenidae+Eumacidae Doubl.

Theclinae Swains.; Theclanae Swains.

Polyommatae Braund.

Micropi Guen.

God shield ye, bright embroider'd train

Of butterflies, that on the plain,

Of each sweet herblet sip;

And ye, new swarms of bees, that go

Where the pink flowers and yellow grow,

To kiss them with your lips.

RONNARD.—*Return of Spring*. (Transl.)

Imago. Head small; front flat or a little tumid, usually protuberant below; vertex separated from the occiput by a continuous sulcation; antennae consisting of from twenty-eight to thirty-four joints, very slender, thread-like, scaled, from as long as to half as long again as the abdomen, the club rather distinct, long and equal, occupying from one-third to one-sixth of the whole antenna; palpi slender, of moderate length, compressed, half the palpus surpassing the face.

Thorax variable, though not greatly, in stoutness, never very stout, sometimes a little compressed; posterior angle of mesoscutellum well marked, acute. Fore

* This species appears in northern Florida certainly as early as April (Scudder) and in central Florida (Haulover, Schwarz) was

found not rare Mar. 17-24; it occurs in abundance in fresh condition on Wilmington Island, Ga., at the end of October (Oemler).

wings with internal nervure obscure or obsolete; hind wings with no precostal nervure, the costal extending nearly or quite to the tip of the costal margin, the basal half of the inner margin channelled to receive the abdomen. Fore legs of male with naked tibial spurs and sometimes a few spines, the tarsi five-jointed and armed like the fore legs of the female, excepting that paronychia and pulvillus are wanting, and, in the place of the claws, either slightly modified apical spines, or the same connate, forming a triangular, slightly arcuate, median hook. Middle tibiae as short as or shorter than the hind pair.

Male abdominal appendages; upper organ consisting mainly of extensive lateral alations, developing differently in the various groups, narrowly united at the base mesially, but always bearing on either side beneath a long and slender, strongly bent or curved, tapering, pointed arm, the extremity of which is directed either backward or partially upward; intromittent organ excessively long, slender, expanding at the tip; clasp slender, generally tapering and much longer than broad, usually pointed at the tip and but slightly armed or wholly unarmed.

Egg. Echinoid or demi-echinoid in shape, much broader than high, the centre of the summit usually depressed considerably; surface pitted, generally conspicuous, with deep or shallow cells, usually bounded by rather heavy walls; micropyle often seated at the bottom of a deep and narrow depression.

Caterpillar at birth. Generally agreeing in the form of the body with the mature condition, but with the contrasts of the summit and sides a little more pronounced, sometimes almost or quite cylindrical. Armed at the angle formed by the flattened dorsal region and the sides, with a series of papillae emitting hairs, some at least of which are exceedingly long, curving backward and minutely spiciferous; also, at the fold separating the sides from the expanded venter, with a series of very numerous papillae bearing long, straight, laterally extending hairs; on the sides one or more longitudinal rows of papillae.

Mature caterpillar. Head small, well rounded, narrower than the narrowest part of the body, smooth, more or less retractile within the first thoracic segment. Body comparatively short and broad, onisciform, the under surface flattened, the upper transversely arched, the dorsal field flattened and the sides often more or less compressed; broadly rounded in front, the first thoracic segment very large and tumid, more sharply rounded behind, the last abdominal segment alone being about as long as broad; otherwise nearly equal or tapering slightly posteriorly; armed with no conspicuous appendages; spiracle of the eighth abdominal segment almost invariably above the line which the others follow. Legs and prolegs very short and small.

Chrysalis. Body short, thick, plump, rounded, with rare exceptions* entirely without angulations, excepting a very slight, blunt elevation at the base of the wings; broadest at about the third abdominal segment, tapering from there in either direction, more rapidly behind than in front. Head entirely on the under surface, the division between thorax and abdomen only slightly marked. Both extremities very bluntly rounded; the whole lower surface straight, often much flattened. Head not at all prominent, ocellar prominences wanting, the prothorax largely developed; wing-scarcely raised above the general surface, their edges not at all thickened. Mesothorax stout, not greatly elevated, but broadly arched longitudinally; metathorax large at the sides, narrow in the middle. Abdomen large and stout, at first broadly arched longitudinally, in the posterior half the slope falling very rapidly to the tip, which is on a level with the under surface.

Cremaster appressed to the body (in *Fenisea*, only, forming an independent prominence), broad, the hooklets (again except in *Fenisea*) either wanting or placed in a curving row at the sides and posteriorly, very slender, generally rather short, the stem equal, the apical portion suddenly expanding into a transverse, slightly convex lamella bent strongly over, the apex transverse. Attached in almost any position by a girt across one of the basal abdominal segments and feebly secured behind by seizing the silken threads with the joints of the posterior segments, or the few hooklets.

* *Fenisea* is the only exception in our fauna.

Distribution. The subfamily is represented in nearly equal numbers on both hemispheres, though two of its members, the Chrysophanidi and Lycaenidi, are very much more numerous in the Old than in the New World. "The oriental and neotropical regions," says Lang (Eur. butt., 74), are where they "chiefly abound and are most magnificent in coloring and design; some of those from South America, for instance, may be fairly said to constitute some of the most beautiful objects in nature." Like most large groups of butterflies, they are far more abundant in the tropics than in the temperate zones, but even in the latter, especially in Europe, they form a large proportion of the species. A very few species have been considered common to both hemispheres, but with how much reason is doubtful; many genera, however, have their representatives in each.

General characteristics. The numerous species comprised in this subfamily, says Trimen (*Rhopalocera Africae Australis* 217-8),

though of small size, are, as a rule, remarkable for brilliancy of colouring and exquisite variegation of marking. Richness of hue is, however, usually confined to the upper surface, which in the male sex often presents one vivid field of metallic orange-red or glistening blue, while in the female it is usually duller, varied with spots, or much suffused with grayish or blackish, and occasionally wholly brown, presenting a totally different aspect to that of the male. The under side, on the contrary, differs but very little in the two sexes . . . ; it is commonly of some soft shade of gray or brownish, marbled or streaked with transverse darker or paler lines, or with rows of white-ringed spots, and is not unfrequently ornamented with very brilliant metallic dots, usually on the hind wings.

It may be added that the antennae are nearly always ringed with white, and that a conspicuous rim of white scales encircles the eyes. Horsfield (*Descr. cat. lep. ins. mus. E. I. Co.*, 40) says: "the intermediate pair [of legs] have on the thighs, in all genera, so far as I have observed, a short, acute process about the middle"; and illustrations are given in some of his plates. Westwood, too (*Mod. class. ins.*, ii: 358, fig. 100: 14), gives a figure "exhibiting the femoral spur and tibial notch"; but these are nothing more than an arrangement of the scales or hairs for the greater mobility of the legs; the denuded femora and tibiae show here no process and no depression whatever.

There is not a little protective resemblance to be seen in the markings, especially of the under surface of the wings, in this subfamily, even in our limited fauna. The early Theclidi, that alight on gray rocks and dead sticks while the foliage is scant, with erect wings, can scarcely be detected, so closely do the colors match the surroundings. The early Lycaenidi appear in the time of violets and hepaticas, whose colors they imitate, and Uhler has noticed how difficult other species were to detect on the flowers of a blue lupine which they frequented. The striped hair streaks alight on leaves where just such lines as they exhibit are a part of

the general make-up of the scenery, and others are of the same vivid green as the plants around which they fly, and which they will not leave.

Habits and haunts. The various genera, continues Trimen (loc. cit.), present considerable diversity of habit, some preferring to settle on the bare ground, others on low plants, some sporting about bushes, and others delighting in the topmost sprigs of lofty trees. The majority are not strong or rapid in flight, and all settle at very short intervals.* . . . Nearly all, if not the whole, of the butterflies of this family, when settled, have a singular habit of rubbing the erect hind wings against each other, so that their upper surfaces press together in a manner resembling that of the blades of a pair of scissors when repeatedly opened and shut. The hind wings are often moved backwards and forwards when half expanded, and in either case the action is so marked that it at once stamps the butterfly as a member of the *Lycaenidae*.

This movement of the hind wings has been repeatedly seen and remarked upon by observers in all parts of the world. Swinton thought he had found the source of the possible sound that may result (none is perceptible to human ears) in the structure of the lowest vein of the front wing. He examined *callophrys rubi*, and states that the vein is bare and "crossed at uniform distances by pronounced striae, which indicate internal diaphragms and constrict into a series of bead-like formations." (Ent. monthl. mag., xiv: 209-10; Ins. var., 118). This statement has been accepted without examination by some entomologists, yet it is not true. The vein is never bare of scales except when they have been rubbed off, and the markings seen by Swinton are either the threads of the enclosed tracheae or the lines of pockets for the attachment of the abraded scales. But what one does find (in all *Lycaeninae*, apparently, certainly in all of our species) is that in the lowest interspace of the front wing, next the inner margin, there is a patch of scales of a different character and setting from any other scales on the under surface. The patch does not reach the base of the wing, nor extend much if any beyond the basal third of the wing, but occupies the whole width of the interspace, and is found in male and female alike, just as the wing movement is shared by both sexes; the scales are slenderer than those about them, subfusiform and bluntly pointed, and very often erect or nearly erect; but they have one other important quality which it seems to me signalizes their use, in that in the midst of scales more lightly attached and easily removed than are those of any other butterflies, it is impossible to remove one of these without breaking the wing; they are firmly set bristle-scales, and on the opposing part of the hind wings, in the marginal interspace, is a similar patch, not so characteristic, of rounded, pavement like scales. If any noise is produced by the movement of the wings, it must be by the agency of these two opposing fields.

Harris, writing of our New England species, says they "are found dur-

*Constant (Catal. Lepid. Var, 23) well remarks that their flight is unequal and spasmodic, so that they easily escape from view, although they never fly far away.

ing the greater part of summer, in the fields and around the edges of woods, flying low and frequently alighting, and oftentimes collected together in little swarms on the flowers of the clover, mint, and other sweet scented plants." Every kind of country, says another writer, furnishes its kinds: "Woods, downs, fields, roadsides and marshes all have their inhabitants belonging to this [sub]family; some are peculiar to mountain districts, and others are content with the cold sunshine of the Arctic regions" (Lang, Eur. butt., 74). Considering the variety of forms peculiar to the mountains of Switzerland and to those of Colorado, it is noteworthy that not a single species characterizes the White Mountains of New Hampshire, which yet support their own *Oeneis* and *Brenthis*. Some of the species exhibit a partiality for particular hours during which they fly abroad. Gosse and Lintner have observed this of some of our species, as will be related in their places. This is perhaps more true in the tropics than with us, where the heat of the sun would seem to be sometimes too great for beast as well as man. "This limited and punctual appearance of many insects is," as Distant says, "an interesting and peculiar phase which has scarcely received the notice that might have been expected." But at whatever hour they appear they are the most spritely of all butterflies, vivacious even to audacious pugnacity, as will appear in several accounts to be related. This is the more remarkable and noticeable from their diminutive size.

Donzel has made the curious observation that when paired and flying, it is the male which flies and carries the female, in the *Lycaenidi*; while the opposite is the case with the *Theclidi*.

Structural features. The butterflies of this subfamily show the last vestiges of that atrophy of the fore legs which is so characteristic a feature of all the higher groups. Here it is confined to the male and consists in a complete or partial loss of the normal terminal appendages; in the highest of the three groups composing the subfamily, *Theclidi*, the tarsi are armed at the tip with a pair of spines which are only slightly larger and more curved than the others; while the inferior surface of the tarsi is furnished with an irregular mass of spines on either side; in the next group, *Lycaenidi*, the terminal armature consists of a single, median, tapering claw, scarcely curved; while beneath the tarsi are supplied with only two or three rows of spines; in the lowest group, *Chrysophanidi*, a single median spine, differing from the others only in size, occupies the tip; while the under surface of the tarsi is armed with frequent spines, usually clustered upon the sides.

The early stages. The eggs are generally very thick-shelled, echinoid or demi-echinoid in shape, studded with connected elevations or with frequent pits; but in one of our species, the reticulation is exceedingly faint, so as to give the surface a strikingly different appearance.

The caterpillars are known by their resemblance to wood-lice, whence the term "onisciform" which has been frequently applied to them; they are naked or pilose; their legs often extremely short, so that they resemble slugs in their sliding movement. The generally minute head, almost always wholly retractile within the greatly enlarged first thoracic segment, the coalesced condition of some terminal joints of the body, and the atrophied legs—features shared in part by the *Lemoniinae*,—are here developed to such an unusual extent as to distinguish these caterpillars from those of all other groups.

They feed upon various exogenous plants, some groups showing a preference for trees and shrubs, others for annuals; a single species will often have a great range of food. Indeed not a few of them are not only polyphagous, but in stress at least will even devour their neighbors whether of their own or another species. Thus Thwaites remarks (Moore, *Lep. Ceylon*, i: 70):

It is difficult to realize that the larvae of some species of these lovely *Lycenidae*, such as *Amplipodla*, etc., are carnivorous or even cannibal in their habits, and do not hesitate to eat their own brethren of the same brood, when any of the latter are commencing their change into the inactive chrysalis state, with their consequent inability to protect themselves from their voracious kindred, who devour them with avidity.

The same carnivorous tendency has been observed in several of our own species; one, indeed, feeds exclusively upon plant lice, and it is not improbable that the habit may be shared by others in other parts of the world, as Dr. Holland has suggested. This habit seems the more curious, as both plant lice and caterpillars of at least one group of *Lyceninae* are often accompanied by ants, who seek them and protect them for the same purpose, namely to lap the sweet exudations which flow from special organs at the hinder extremity, of which further details will be given under the *Lycenidi*. Thwaites, in the passage above quoted, goes so far as to say that the ants actually protect them from their cannibalistic brethren. Nature, says he,

finds a protection for these said helpless individuals, in the instinct of a species of ant (*Formica smaragdina* Fabr.) which, finding a substance most palatable to it secreted naturally from a glandular defined spot upon the bodies of these helpless larvae, takes possession of them as "cows," surrounding each separate one and the leaf on which it had been feeding with a few silken strands of its web, protecting them jealously and attacking most fiercely any living thing intruding upon them.

Whatever the value of this statement, we must confess to a doubt whether the ants spin the web seen. The secretions which are thus attractive to ants are exuded from an evaginable vesicle in the middle of the dorsum of the seventh abdominal segment, which appears to be found in the caterpillars of all *Lycenidi*, but only in some of the other tribes, though only a few of them (and these all *Lycenidi*) are known to be attended by ants. Some of the caterpillars which possess this vesicle,

but not all, possess also a pair of lateral evaginable caruncles on the back of the succeeding segment.* No such abdominal structures are known in the caterpillars of any other group of butterflies.

The chrysalids are short, plump and ovate, rarely with the slightest angulation, the head always and the terminal segment almost always upon the under surface of the body, in which character they differ from nearly all other butterflies.

The Lycaeninae usually pass the winter either in the egg or chrysalis state; occasionally perhaps as caterpillars but never as butterflies. When they winter as chrysalids they frequently select as a place of hibernation a station on or close to the ground. In general they appear to be single brooded, although occasionally two or even three broods of a species may succeed each other in the course of a season. They are usually solitary in their habits, although occasionally a colony of caterpillars is found on a single plant or cluster of plants. Professor Westwood long ago published curious accounts of an Indian species, small companies of which live in the caterpillar state in the interior of pomegranates and even undergo their transformations within the fruit. (Trans. ent. soc. Lond., ii: 1-8, pl. 1.)

Table of tribes of Lycaeninae, based on the egg.

Egg flattened tlarate, almost as much depressed above as truncate below; central depression of summit (including, but not limited to, the micropylle pit) one-fourth or more the diameter of the egg, or the whole summit flat; angles of cells marked by prominences rising conspicuously above the general surface.

Generally larger, the central depression (as above) covering one-fourth to one-half the width of the egg, the micropylle pit generally deep.....**Theclidi.**

Generally smaller, the central depression generally covering from one-half to three-fourths the width of the egg, the micropylle pit comparatively shallow.....**Lycaenidi.**

Egg domed tlarate, much less depressed above than truncate below, the central depression of the summit less than one-eighth the diameter of the egg, the whole summit otherwise distinctly convex; angles of cells without, or with only slight, prominences.....**Chrysophanidi.**

Table of tribes, based on the caterpillar at birth.

Head noticeably narrower than the body; first thoracic segment scarcely larger than the others; last three abdominal segments more or less fused and furnished above in the centre with a large, sunken, subcircular area, in front of which on either side is a curving series of several smooth, naked papillae.....**Theclidi.**

Head nearly or quite as broad as the body; first thoracic segment distinctly larger than the others; seventh abdominal segment wholly free and with no papillae besides those of the longitudinal series.

First thoracic segment not greatly larger than the others; last two abdominal segments fused; uppermost range of bristles laterodorsal, these generally not much longer than the width of the body.....**Lycaenidi.**

First thoracic segment generally very much larger than the others; the eighth abdominal segment wholly free; uppermost range of bristles subdorsal, generally almost or quite half as long as the body.....**Chrysophanidi.**

* See also the Introduction, p. 15; and Proc. Bost. soc. nat. hist., xxiii: 357-358.

Table of tribes, based on the mature caterpillar.

- Head excessively small, not one-fourth, sometimes not one-sixth the width of the body; dorsal shield of first thoracic segment wanting, or else covered with hairs as thickly as the neighboring parts.....**Lycænid.**
- Head moderately small, generally at least one-third, sometimes one-half the width of the body; dorsal shield of first thoracic segment distinct and naked or clothed much less abundantly with hairs than the neighboring parts.
- Highest portion of body segments lying behind the middle, generally next posterior edge; or if in the middle with the posterior slope more abrupt than the anterior; head generally smaller than in Chrysophanidi, capable of being extended two or three times its length beyond the body.....**Theclidi.**
- Highest portion of body segments at the middle or in front of the middle of the segments, the anterior slope the more abrupt; head generally larger than in Theclidi, not capable of special extension.....**Chrysophanidi.**

Table of tribes, based on the chrysalis.

- Dermal appendages formed of cylindrical, spiculiferous and pointed or apically stellate hairs.
- Dermal appendages tapering only at the tip, the spicules inclined at a slight angle. Whole body shorter and stouter than in Lycænid, the abdomen especially being very short and full, rarely more than half as long again as broad.....**Theclidi.**
- Dermal appendages tapering throughout or apically stellate, the spicules, when present inclined at a right angle. Whole body longer and slenderer than in Theclidi, the abdomen especially being more elongate, generally nearly twice as long as broad....**Lycænid.**
- Dermal appendages short, distinctly fungiform, without spicules.....**Chrysophanidi.**

Table of tribes, based on the imago.

- Third superior subcostal nervule of fore wings simple; under surface of hind wings generally with continuous or subcontinuous markings.....**Theclidi.**
- Third superior subcostal nervule of fore wings forked; under surface of hind wings generally with discontinuous, though ranged markings.
- Stouter bodied, with colors of upper surface usually more or less violet; spines on under side of tarsi comparatively few and ranged in pretty regular series; clasp tapering, apically pointed.....**Lycænid.**
- Slenderer bodied, with colors of upper surface more or less coppery; spines on under side of tarsi numerous and clustered irregularly at the sides; clasp subequal, apically rounded.....**Chrysophanidi.**

TRIBE THECLIDI.

HAIRSTREAKS.

- Papilionæ subcaudati Wiener Verzeichniss. Theclides Kirb.; Theclinae Butl.; Theclidae Ephori Herbst. Guen.
- Armata Hübner.

Lass ab von mir, und liebe nur
Die heiteren Schmetterlinge,
Die da gaukeln im Sonnenlicht—
Lass ab von mir und dem Unglück.

HEINE.—*Lass ab.*

Imago. Colors dark brown. Club of antennae usually increasing in size throughout most of its extent, very long and very slender, from two to three times as broad as the stalk (occasionally a little more than that) and from five to eight times longer than broad. Patagia very long and slender, usually four or five times longer than broad; third superior subcostal nervule of fore wings not forked; tarsi armed beneath with an irregular mass of spines on either side; fore tarsi of the male armed at tip with a pair of spines, only slightly larger and more curved than the others; parony-

chia of other legs simple; pulvillus small but prominent. Upper organ of male abdominal appendages with very broad alations, expanded laterally rather than posteriorly; clasp straight, unarmed, tapering, generally to a very delicate point; intermittent organ of exceptional length, apically flaring.

Egg. Tlarate, about equally truncate above and below, the flat or sunken portion of the upper surface, including, together with the micropyllic pit, fully one-fourth, sometimes more than one-half the diameter of the egg, regularly and very profusely studded with high and rather coarse prominences of varying character, connected by a lower, almost equally coarse tracery, within which the pit-like cells are situated; micropyllic pit very deep with steep walls.

Caterpillar at birth. Head smooth, distinctly narrower than the first thoracic segment. Thoracic and abdominal segments of about equal width. The hinder segments of the abdomen fused and fully twice as long as those immediately preceding it, furnished a little behind the middle with a large circular coriaceous depression. The first thoracic segment similarly furnished with a lozenge-shaped, laterally produced, coriaceous shield. Abdominal segments furnished with regular series of tall conical papillae, bearing spiculiferous hairs, which extend to a certain extent upon the thoracic segments but on them lose in part their serial character. On the abdominal segments there is always found a laterodorsal series, consisting of two or more, bearing long curving hairs directed to a greater or less extent backward; while beneath the spiracles is a compound series of from three to five longer and shorter, generally straight and outward directed hairs. Between the laterodorsal series and the spiracles is a lateral series of smooth, hemispherical, naked lenticles, and on the last compound abdominal segment a curving series of four or five similar lenticles of unequal size.

Mature caterpillar. Body slightly slenderer than in the other groups; segments scarcely prominent in any part, body covered with hairs, mostly very short, but at the laterodorsal ridge and the substigmal fold they are two or three times longer, though still short.

Chrysalis. Body shorter and stouter and especially the whole* abdomen fuller than in the other tribes; dermal appendages consisting of cylindrical hairs, which are equal, tapering only at tip, profusely provided with minute spicules, which diverge at a slight angle from the stem.

This tribe of Lycaeninae contains some of the most attractive butterflies. Their elegant form, delicate markings, small size and active movements all combine to render them very fascinating. They may generally be distinguished from the other tribes by their more angulated fore wings, their dark brown colors and by the delicate striped markings on the under surface of the wings, markings which have gained for these butterflies the popular name of "Hair streaks." Their hind wings are also commonly furnished with thread-like tails—whence the title *Armati*, given them by Hübner. The anal angle of the hind wings is not infrequently lobed and bent downward at a right angle; and the fore wings of the male often bear a small, dull, oval spot near the middle of the front margin, which is filled with androconia and frequently disturbs the regularity of the veins at that point. Besides this secondary sexual peculiarity, the front of the face of the male bears a kind of beard, a bristling tuft of hair like scales, wanting, or very thin, in the female.

* Fenisea, one of the Chrysophauidl, has a fuller abdomen than any of the Theclidi, but it does not embrace the whole of it, the last two segments forming a somewhat independent cremastral mass.

They are frisky little creatures, very fond of chasing each other through the air and tumbling about with surprising quickness of evolution. . . . After a flight [they] often return like flycatchers among birds to the same spot from whence they departed; a projecting twig, or the topmost leaf of a bush. (Gosse, Lett. Alab., 37.)

You may see the females walking about the leaves, sunning themselves; while the males are fluttering in attendance, or pertinaciously holding a tournament in honour of their lady loves; in these pugnacious encounters they maul each other severely. (Douglas, World of Ins., 194.)

Wallace in writing of the South American forms says they "all fly very quickly and settle upon leaves and flowers with the wings erect. They have a very peculiar habit of moving the two lower wings over each other in opposite directions, giving an appearance of revolving discs." (Trans. ent. soc. Lond., [2] ii: 263.) This habit is found in several, perhaps all, of our genera.

The group is about equally represented in the Old and New Worlds; the same is true of the north temperate zones considered apart; only one of the six New England genera, however, is common to both hemispheres, and yet the tropics of the New World nourish the vast majority of the species most closely allied to those of Europe and North America.

The eggs are echinoid shaped, studded with numerous projections, connected by radiating ridges; they are laid singly. The larvae feed on trees and shrubs rather than on herbaceous plants, and do not differ greatly from those of the other tribes, though they are generally flatter and more slender; *depressoscutatae* was the descriptive term applied to them by Denis and Schiffermüller.

Rosaceae, Leguminosae, Ericaceae and Cupuliferae seem to be more frequently chosen for food than other plants; several species are known to bore into and devour the interior of fruits, the first case known being up to the present time the most remarkable; in this, the pomegranate is the fruit attacked, and several of them inhabit a single fruit, living in the interior; when they find the fruit weakening, they eat a hole to the surface a quarter of an inch in diameter (having entered when much smaller), secure the stem of the fruit to the branch by silken cords and return to the fruit, where they undergo their transformations, the butterflies escaping presumably with moist wings by the same hole (Westwood, Trans. ent. soc. Lond., ii: 1-8, pl. 1).

The chrysalids, too, are similar to those of the other groups but stouter. The insects are nearly all single brooded and pass the winter either in the egg or chrysalis; the single brooded species which hibernate as chrysalids are among the earliest of our butterflies and complete their annual cycle before the middle of July—even much earlier in the south, and yet the intense summer heat has no power to rouse the chrysalids from the deep sleep in which they remain three-fourths of the year.

Table of genera of Theclidi, based on the egg.

- Prominences closely approximate, at least as close as one-twentieth the diameter of the egg.
 Egg more than twice as broad as high.....**Erora**.
 Egg less than twice as broad as high.....**Uranotes**.
 Prominences distant, not nearer than one-eight the diameter of the egg.....**Mitura**.
 Prominences at a medium distance apart, from one-tenth to one-eighth the diameter of the egg.
 Egg more than twice as broad as high.....**Incisalia**.
 Egg less than twice as broad as high.
 Summit of egg broadly domed almost throughout.....**Strymon**.
 Summit of egg flat for at least half the diameter of the egg.....**Thecla**.

Table of genera, based on the caterpillar at birth.

- No hair-bearing series of papillae between the spiracles and the series on the laterodorsal ridge.
 Each abdominal segment with only one large and one small papilla in the laterodorsal series.
 Third thoracic segment with a naked papilla on lateral line; the two smaller adjacent papillae of last compound segment one behind the other.....**Thecla**.
 Third thoracic segment with no lateral papilla; the two smaller adjacent papillae of last compound segment placed transversely.....**Strymon**.
 Each abdominal segment with two large papillae and one small papilla in the laterodorsal series.....**Incisalia**.
 A laterostigmatal series of hair-bearing papillae.....**Mitura**.
 (Erora and Uranotes unknown.)

The materials for a table based on the mature caterpillar are not at hand.

Table of genera, based on the chrysalis.

- A delicate dorsal carina on prothorax and mesothorax.....**Incisalia**.
 No distinct dorsal carina.
 Abdomen much wider than thorax; hair-bearing papillae conical.
 Raised tracery of lines on surface low and obscure; longest hairs nearly half as long as segments.....**Uranotes**.
 Raised tracery of lines on surface distinct and sharp; longest hairs not one-fourth the length of segments.....**Mitura**.
 Abdomen scarcely wider than thorax; hair-bearing papillae hemispherical.....**Thecla**.
 (Strymon and Erora not examined.)

Table of genera, based on the imago.

- Hind wings without thread-like tails, at most lobed at some of the nervure tips.
 Hind wings of very different shape in the two sexes, the outer margin not crenulate; male with a discal stigma on the fore wing.....**Strymon**.
 Hind wings not greatly differing in form in the two sexes.
 Hind wing with no excision of the inner margin, the outer margin not crenulate; male with no discal stigma.....**Erora**.
 Hind wing with a considerable apical rounded excision of the inner margin, producing a conspicuous lobe at the inner angle, the outer margin crenulate; male with a discal stigma on fore wing.....**Incisalia**.
 Hind wings with one or two thread-like tails.
 Submedio-internal interspace of hind wing apically lobed; tail of lowest median nervure a third as long as the wing; male with no discal stigma on fore wing.....**Uranotes**.
 Submedio-internal interspace of hind wing not apically produced; tail of lowest median nervure less than a fourth the length of the wing; male with a discal stigma on fore wing.
 Antennae comparatively short, the club short and stout, nearly three times as thick as the stalk and only five times as long as broad.....**Mitura**.
 Antennae comparatively long, the club long and slender, scarcely twice as thick as the stalk and eight times as long as broad.....**Thecla**.

STRYMON HÜBNER.

Strymon Hübner, Verz. bek. schmett., 74 Thecla Auctorum.
(1816).

Type.—*Chrysophanus mopas* Hübner.

Nay, a light tuft of bloom towered above
To be toyed with by butterfly or bee,
Done good to or else harm to from outside.

BROWNING.—*The Ring and the Book.*

Imago (55:4). Head rather large, densely clothed with scales, and, rising but little above them, a rather abundant supply of short, curving hairs. Front nearly flat, with a slight broad furrow down the middle above; below it, slightly tumid down the middle, at the lower extremity a little protuberant, and here only surpassing the front of the eyes; more than half as high again as broad, and nearly or quite as broad as the front view of the eyes; middle of upper border forming a very slight blunt ridge, the corners rather largely hollowed in front of the antennae; lower border greatly arched, the sides parallel. Vertex tuberculate in the middle and on either side next the outer posterior edge of the antennae; separated from the ocellus by a transverse, sinuous, somewhat deep channel. Eyes rather large and full, sparsely pilose with very short hairs, which become shorter on every side toward the periphery. Antennae inserted with the posterior border of the base in the middle of the summit, separated by a space nearly or quite equal to the diameter of the basal joint; nearly half as long again as the abdomen, consisting of thirty-three or thirty-four joints, of which the last fourteen form an elongated, cylindrical, somewhat compressed club, scarcely twice as broad as the stalk, about six times as long as broad, at first increasing very gradually in size, equal for most of its length, becoming small just before the tip, which itself is well rounded. Palpi slender, rather compact, longer than the eye, the last joint half as long as the penultimate, and furnished with recumbent scales, while the others are heavily clothed with large, loose scales projecting forward and upward, although but little beyond the lower border of the palpus.

Patagia extremely long and slender, and, excepting inner margin, a little arched and slightly tumid, four or five times longer than broad, basal half tapering slightly, apical half nearly equal, slightly bent outward, not half so broad as base, tip rounded.

Fore wings (39:15) fully two-thirds as long again as broad, the costal margin a little convex and expanded next the base, beyond, to an equal distance from the tip, straight, and then curved downward somewhat at the tip, the outer angle a little rounded; outer border equally and but little curved (φ), or equally and slightly convex on the upper two-thirds, below straight, scarcely continuous with the lower portion of the curve (δ), its general direction being at an angle of about 50° with the middle of the costal margin; inner margin straight, the outer angle rounded off. Costal nervure terminating a little beyond the tip of the cell; subcostal with three superior branches, the first arising in the middle of the outer four-fifths of the upper margin of the cell, the second less than one-third way from there to the apex of the cell (δ), or scarcely more than half way to the same (φ), the third a short distance beyond the second (δ), or at the very apex of the cell (φ), the main vein slightly flexed beyond it in the male in the middle of the discal spot, turned upward again at the tip of the cell, and terminating below the tip of the wing; inferior subcostal nervure connected to the main stem by an exceedingly weak cross vein, distinct only in its upper half, and to the submedian by a cross vein weak throughout. Cell half the length of the wing, and nearly or quite four times as long as broad.

Hind wings with the costal margin strongly rounded, at the base much more so than beyond, being here greatly expanded, the outer angle well rounded, the outer margin pretty regularly and slightly rounded, the lower portion produced much more than the upper, slightly and roundly emarginate in the medio-submedian interspace, and below

it a little and roundly prominent ($\mathcal{J}$), or pretty regularly and considerably rounded, most produced and a little full in the subcostal region, the lower portion continuous ($\mathcal{Q}$), the inner margin convex and considerably expanded, in the outer third somewhat excised and slightly emarginate. Submedian nervure terminating on the outer border just beyond the anal angle; internal nervure terminating somewhat beyond the middle of the outer border.

Androconia wedge-shaped but broadly truncate at tip, the sides straight, the stem long, the lamina about four times as long as broad.

Fore tibiae about four-fifths the length of the hind tibiae, the tarsi either surpassing ($\mathcal{Q}$) or surpassed by ($\mathcal{J}$) the tibiae, together equal in the two sexes; the last joint either like that of the other legs ($\mathcal{Q}$); or small, tapering, and only armed with the continuation of the rows of spines on the under surface, and above with very short and dense hairs in place of scales ($\mathcal{J}$); in both sexes the tibial spines are naked, and excepting in these points and their diminished size they do not differ from those of the other legs. Femora scarcely fringed with hairs, excepting on the fore legs of the male, where they are thickly clothed. Middle tibiae armed beneath with a great many rather recumbent, short and rather slender spines, and at the tip with rather long and stout spurs, clothed with scales nearly to the tip. First joint of tarsi a little longer than the three following together, the second and fifth about equal, and longer than the third and fourth, which are equal; armed beneath on either side with rather long and slender spines, the apical ones of each joint a little longer than the others; under surface, excepting of the basal joint, devoid of scales. Claws very small, compressed, bent strongly close to the base, beyond nearly straight, tapering, the apex very slightly hooked and finely pointed; paronychial simple, consisting of a rather slender, equal, fleshy lobe, not so long as the claws, and recumbent on the fleshy base; pulvillus minute, projecting.

Male abdominal appendages; upper organ rather small; alations subquadrate, separated by a deep, broad notch, as in *Thecla*, not pointed; lower edge produced to a broad, rounded lappet; arms long and slender, tapering to a fine point, strongly recurved, the apical portion straight; clasps gibbous at base, beyond laminate, rather stout, tapering to a point.

Egg. Echinoid shaped, much flattened below, above as in *Uranotus* or even more strongly convex. The surface covered with coarse, raised, rounded projections, each connected with those around it by a laminate ridge, much the lowest in the middle, and thus forming minute, triangular cells. Inferior surface, except exteriorly, smooth; above, the projections suddenly stop at the slightly sunken micropyle, composed of delicate polygonal cells, with slight raised ridges between.

Caterpillar at birth. Body shaped much as in *Inclisalia*, with no sulcation of the dorsal area. The last compound abdominal segment somewhat elongated but rounded at the tip. The laterodorsal series of spiculiferous hairs consisting of two on each abdominal segment, the larger central, the smaller posterior and outside of this; the longer hair is scarcely so long as the height of the body, strongly curved, sweeping upward and backward; the smaller half the length of one of the segments of the body, curving, recumbent, backward directed. No laterostigmatal series of hair-bearing papillae. Of the infrastigmatal series the central hair is the longest and about one-third the width of the body, directed straight outward; the other, anteriorly situated, is half as long, and directed slightly forward and placed a little superior to it. Beneath these is a pair of two equal, divergent and slightly downward directed hairs on either side of the middle. The lateral series of hairless, hemispherical lenticles contains one on each abdominal segment just in advance of the middle, but that on the first abdominal segment is carried forward to the anterior edge, and accompanied by a second similar, but slightly smaller, lenticle just behind and below it; this series extends also upon the second thoracic segment but is absent from the third. On the last segment the lenticle of this series forms with three others an open curve, posteriorly diverging from the similar series on the opposite side, and accompanied on the laterodorsal line by a pair of smaller, also naked, lenticles placed side by side, transversely, behind them.

As this American genus appears to consist of only a single species whose geographical distribution is given below, nothing need be added here upon that point. The species occurs not uncommonly in the southern half of New England.

The two sexes of the butterflies are quite different in appearance so far as the shape of the wings is concerned, those of the hind pair being broadly rounded in the female, but sharply bent at the anal angle in the male; in both they are destitute of tails. They are of rather large size for Theclidi,—the largest among our New England forms—dark uniform brown above, scarcely paler below, where they are ornamented with a marginal series of red spots, bordered with black, nearly or quite obsolete on the fore wings, and with a slightly sinuous series of roundish, black spots in the middle of the outer half of the wings.

The butterflies are single brooded, hibernating in the egg state; the caterpillars feed on Rosaceae; the chrysalids continue for about a fortnight and the butterflies appear in July and lay their eggs in August. They are rapid flyers but are easily taken upon flowers, of which they are very fond and to which they often resort in companies.

The juvenile larvae are described as of a roseate color, brighter on the sides, sparingly clothed with curving hairs, mostly directed backward, and longer than the body itself. The full grown caterpillars are slender and the sides of the body slope acutely from the dorsal field; their color is green with rosy patches in front and behind and they are thickly covered with microscopic hairs. The chrysalids are by no means so slender as the larvae, of a pale, glossy brown with darker dots.

EXCURSUS XXVI. — HYPERMETAMORPHOSIS IN BUTTERFLIES.

Liebes, leichtes, luft'ges Ding,
Schmetterling,
Das da über Blumen schwebet,
Nur von Thau und Blüten lebet,
Blüte selbst, ein fliegend Blatt,
Das, mit welchem Rosenfinger!
Wer bepurpurt hat?

War's ein Sylphe, der dein Kleid
So bestreut,
Dich aus Morgenduft gewebet,
Nur auf Tage dich belebet?
Seelchen, und dein kleines Herz
Pocht da unter meinem Finger,
Fühlet Todesschmerz.

Fleuch dahin, O Seelchen, sei
Froh und frei.
Mir ein Bild, was ich sein werde,
Wenn die Raupe dieser Erde
Auch wie du ein Zephyr ist
Und in Duft und Thau und Honig
Jede Blüte küsst.

HERDER.—*Das Lied vom Schmetterlinge.*

EVERY caterpillar in its growth from the egg to maturity changes the character of its coating. I do not refer to that periodic sloughing of the skin common to the early stages of all insects, the reason for which is quite apparent, since otherwise their inelastic coats would be too strait for

their rapidly growing bodies. But I call attention rather to the fact that with the first sloughing of the integument an entirely different set of appendages is assumed. The fresh integument of subsequent moultings may be likened to a new spring suit, very like the old one, but bright and clean; while the difference of armature accompanying the first moult is more like the difference between the dress of a child and of a man. The dress of our manhood differs as much from that of our infancy as it does from the dress of a savage; in like manner the clothing of a full grown caterpillar often differs as much from its clothing at birth as it does from that of a caterpillar belonging to a different tribe.

To present a few examples: The mature caterpillars of our brown meadow butterflies or satyrs, *Satyrinae*, have a rough skin, the result of a multitude of minute tubercles; each of these tubercles bears a simple hair, scarcely visible to the naked eye. In the young caterpillar of these butterflies the skin, instead of being supplied with an almost innumerable number of microscopic hairs, is furnished, in some instances, with an exceedingly scanty number of little club-shaped bristles, proportionally many times longer than the hairs of the adult, sometimes much longer in front and behind than in the middle of the body, and arranged in definite, longitudinal series; in still others it is furnished with compressed, ribbon-like hairs, as long as the body, serrated on one edge and bent in the middle; on the abdominal segments these hairs point backward and on the thoracic forward; that is, the caterpillar wears a bang.

In the *Nymphalidi* the segments of the young caterpillar are equal in size and have regular series of stellate warts; in the mature caterpillar the body is grotesquely hunched, while the warts have changed to very variable tubercles, one set, mounted on the highest hunch, presenting a formidable appearance as a pair of knotted clubs as long as the breadth of the body. In the *Monarch* or milk weed butterfly, *Anosia plexippus*, the full grown caterpillar is naked, but adorned with a pair of long, thread-like, fleshy, flexible tentacles at either extremity of the body; in the young caterpillar these tentacles or filaments are absent, but their future position is marked by little conical, black points, while the body is covered with minute black bristles, arising from still more minute warts, and arranged six on the back of each segment, placed four in a row in front, one on each side behind, and three on either side of the body, one in the middle of the segment and two below.

In the anglewings, *Vanessidi*, which furnish our ordinary spiny caterpillars, these spines are compound in the adult (that is, they bear subsidiary spinules), and are arranged in certain definite rows. In their earliest life, these same caterpillars are furnished with long, tapering hairs also arranged in definite series, but not occupying the same position as the spines of the mature caterpillar. Now in each genus of spiny

caterpillars the spines occupy a certain fixed place, and by means of this feature, among others, we define the genus. Here then young and old caterpillars plainly differ from each other in generic features. The case of the spiny caterpillars is still more striking in the *Heliconians*, to judge from the changes in *Agraulis vanillae* and *Apostrophia charithonia*. For here the appearance of the new born caterpillar is entirely different from its appearance after its first moult. In the first stage the head is unarmed and the body supports longitudinal rows of very large papillae, each bearing a long, slender, naked hair with a delicate, ovate, apical club; there are at least four longitudinal series of these hair-bearing papillae above the prolegs. After the very first change of skin the head is armed above with a pair of stout spines nearly as long as itself, bristling with distant thorns; the papillae and peculiar hairs of the body have entirely disappeared and in their place are long, tapering spines as high as the body itself, with a very slight basal enlargement and furnished along their whole length with minute papillae supporting little needles. The position of these spines is quite different from that of the papillae of the first stage and as if to mark this more distinctly there are but three longitudinal series above the prolegs. These differences become intensified in every subsequent ecdysis.

To a casual view the caterpillars of our blue butterflies, our coppers and hair-streaks, appear quite naked; they are, however, profusely covered with microscopic hairs; but the newly hatched caterpillars are provided with long hairs sweeping backward behind their bodies, most of them arranged in longitudinal series; the hairs themselves, too, instead of being simple, as in the adult, are covered with microscopic spicules. So, too, they are furnished in this early stage with rows of chitinous annuli or lenticles, wholly wanting in the adult. In our white and yellow butterflies, *Pierinae*, the pests of the garden and the glory of the fields, the differences between youth and old age are much the same as in the meadow butterflies first mentioned. In a general way, the same may be said of the skippers, but the appendages of the new-born caterpillar are always shaped like little clubbed mushrooms, and under the microscope bear an odd resemblance to a row of cabbages in a vegetable garden. The caterpillars of our swallow-tails, at least of those common in New England, are always nearly naked when full grown; we may find a few scattered hairs by searching with a lens, and here and there a minute tubercle, or a smooth and shining lenticle; in some species the front part of the body is swollen and furnished with striking eye-spots; at birth, however, the body is always cylindrical and supplied with several prominent series of bristle-bearing tubercles, one tubercle to a segment in each row, and one row often more conspicuous than the others. Sometimes the entire body bristles with these appendages.

Instances have thus been given in every one of the larger groups of butterflies to show the universality of this feature in the development of the caterpillar; many of the changes are gradual in their appearance, and grow more complicated with advancing life; but the more important changes between the different stages of a caterpillar's life occur at the first moulting; that is, those features of the young caterpillar not possessed by the adult are those which it has brought with it from the egg, and which are lost when its embryonic skin is cast. We should, therefore, naturally suppose these peculiarities to have some reference to its condition in the egg; but this view can hardly be maintained, for certainly the most appropriate condition for a caterpillar in the egg would be entire absence of clothing or a uniform covering of silky hairs, conditions which are exactly the ones which do not occur. On the contrary, in every instance we can find, caterpillars which at maturity are naked or nearly so, or clothed uniformly with hair, when newly hatched, bristle with tubercles or are supplied with cumbrous serrated or spiculiferous hairs. Some other explanation must therefore be sought.

From the great diversity in the character of the metamorphoses of insects and the nature of the differences between them, it has been argued with great force and reasonableness, and the argument is now generally accepted by naturalists, that all of these metamorphoses and especially such complete changes as are undergone by a butterfly during its varied life from egg onward, are acquired characteristics, gradually gained in the struggle for existence by adaptive devices; that is to say, there were perfect insects before there were caterpillars and chrysalids, or indeed larvae and pupae properly so called of any kind. This is not the place to discuss or even to state more fully the grounds for this conclusion. But granted its correctness, we might reasonably look among insects in which metamorphosis had been carried furthest for some indications of its still greater development. Now inasmuch as the chrysalis is as complete an example of adaptation to its purpose as could well be conceived, where between the two ends of the scale could be interpolated any further metamorphosis than in the growing and feeding caterpillar with its frequent changes of skin? And if metamorphoses were originally acquired to fit the creature for the contrasted circumstances of its earlier and later life, can we be far wrong in assuming that the conditions of existence are very different to a young creature just from the egg, so small as hardly to be seen, and its full grown self one hundred fold as large, able to pass from an exposed to a concealed position rapidly? If not, why are webs and other manufactured concealments so much more common in early than in later life? And why, with the Pamphilidi, which live in concealment all their lives, are only the younger stages provided with long, recurved bristles on the terminal segments, that they may rapidly withdraw them-

selves within their burrow-like nests? May we not look upon the distinctive clothing which juvenile and mature caterpillars of butterflies possess, features common to all the group, as the first step toward a further stage of metamorphosis—in short a hypermetamorphosis, akin in nature, but not yet in degree, to that so well known to entomologists in the early stages of many grubs of the Coleopterous family Meloidae?

That this peculiar investiture and form of caterpillars in their final embryonic stage, as they leave the egg, is adaptive, a form of protection against the dangers that will beset them when they leave the egg is I think tolerably clear. In the first place caterpillars having in their later life special provision against enemies are practically unprovided with that class of safeguards in their earliest stage; thus I have never been able to induce any caterpillars of the Papilioninae while in their first stage to protrude the osmateria, with which nevertheless they are provided from birth and which they use freely in after stages. Again, the single feature common to the appendages of the vast number of embryonic larvae is that these are apparently hollow tubes, having presumed connection with basal glands, and thus serving as channels for the conveyance of fluids, probably protective, from such glands; for these appendages nearly always flare at the extremity, being more or less trumpet shaped, and often can be seen to hold a droplet of fluid within the embrace of the lips of the trumpet.

It is immaterial to our present purpose whether the embryonic or the mature stage of investiture and form in caterpillar life be looked upon as the elder; we only wish here to urge that a hypermetamorphosis is now in the process of origination through the differentiation of the larval characteristics, of the same kind and following the same direction as that which has resulted in metamorphosis from the earlier uniform conditions of structure and life to the later. Considering, however, the comparative uniformity of the embryonic and the diversity of the adult characters, with the naturally more widely varied conditions of life to which the adult must be subjected, it may be regarded as probable that the hypermetamorphosis is rather in the direction of the evolution of the later ontologic stages. In further support of this view is the fact that the peculiar protective structures of the first stage—the trumpet-tipped dermal appendages—endure throughout life in the lowest family, the Hesperidae, possibly also in some Pierinae, are lost at various stages in other Pierinae and in the Papilioninae, and never surpass the first stage in the highest family, the Nymphalidae, and probably do not in the Lycaenidae.

That in other insects also the first stage of larval life is thus differentiated from the remaining stages I have elsewhere pointed out. Presumably this form of hypermetamorphosis will be found to exist in nearly if not all larvae belonging to groups, the most of whose members live in exposed situations, and which have anything more than the most "incomplete" metamorphosis.

Many species of Papilioninae
have the osmateria, etc.
More or less

STRYMON TITUS.—The coral hair-streak.

[Little brown butterfly (Abbot); coral hair-streak (Gosse); Mopsus butterfly (Harris); cherry tree Thecla (Saunders); coral streaked butterfly (Maynard).]

Hesperia titus Fabr., Ent. syst., iii: 297 (1793).

Lycæna titus Westw.-Hewitts., Gen. diurn. Lep., ii: 494 (1852).

Thecla titus Steph., Cat. Lep. Brit. mus., i: 260 (1850);—Middl., Rep. ins. Ill., x: 94—by careless printing a part of the text belongs to *Cyaniris pseudargiolus* (1881);—Saund., Ins. inj. fruit, 219, fig. 224 (1883);—Fern., Butt. Me., 86-87 (1884);—French, Butt. east. U. S., 278-279 (1886);—Mayn., Butt. N. E., 38-39, pl. 4, figs. 48, 48a (1886).

Strymon titus Butl., Cat. Fabr. Lep., 191 (1869).

Chrysophanus mopsus Hübn., Zutr. exot. schmett., i: 24, fig. 135-136 (1818).

Strymon mopsus Hübn., Verz. bek. schmett., 74 (1816?).

Thecla mopsus Boisid.-LeC., Lép. Amér. sept., 100-110, pl. 34, figs. 1-6 (1833);—Gosse, Lett. Alab., 148 (1859);—Morr., Syn. Lep. N. Amer., 102-103 (1862);—Harr., Ins. inj. veg., 3d ed., 278-279 (1862);—Reak., Proc. entom. soc. Philad., vi: 146 (1866);—Saund., Can. ent., i: 96-98 (1869);—Pack., Guide ins., 266-267 (1869).

Papilio———Abb., Draw. ins. Ga., Brit. mus., vi: 56, figs. 170-178 (ca 1800).

Polyommatus titus God., Encycl. méth., ix: 614, 688 (1819).

Figured by Abbot, Draw. ins. Ga., Oemler coll., Bost. soc. nat. hist., 17;—Glover, Ill. N. A. Lep., pl. B, fig. 9, pl. E, figs. 21, 22, ined.

Schwebt neller, huc Lüfte,
O kommt, ihr Wiesendüfte,
Ihr Schmetterlinge, tummelt euch,
Von Zweig zu Zweig
Mit unsrer Schaar zu spielen
Im kühlen,
Im säuselnden Gesträuch!

SCHULZE.—*Lied der Vöglein.*

These be the pretty genii of the flow'rs,
Daintily fed with honey and pure dew.

HOOD.—*The Plea of the Midsummer Fairies.*

Imago (6: 24, 26). Head covered with moderately long, blackish brown hairs, varied by narrow streaks of white scales and hairs; eyes encircled with a moderately narrow band of snow white scales, which reach the base of the antennae in front, but fail of reaching it, by the diameter of the basal joint, behind; those of either side are united by a transverse, slightly curved band of similar scales just above the base of the tongue; the compressed and slightly elevated tuft of hairs on the summit of the head has a median line of slightly longer white or dull white hairs. The basal joint of the antennae is tightly encircled by a cup of scales, snow white externally and above, dark brown elsewhere; antennae covered with black scales, annulated, on the lower fourth of each joint of the stalk and on the basal three or four joints of the club, with snow white scales; the edges of these annulations are rather even at base, very irregular at apex; club black with a bronze tinge on the upper surface, mouse brown, most delicately flecked with very short minute gray hairs on the under surface of the male, the base of each joint more or less distinctly banded with yellowish brown, which sometimes expands so as to occupy nearly or quite all of the lower surface; the whole basal portion of the under surface of the club is profusely flecked with white scales, which run up highest on the outer side; the terminal three or four joints of both sexes are entirely honey yellow, sometimes slightly infuscated, but at all times have a fulvous appearance to the naked eye. Palpi covered with snow white scales on the inner face and under edge of basal and middle joints, on scarcely so much as the lower half of the outer face of the middle joint, on the base of the upper and sometimes of the inner portion and on the extreme apex of terminal joint, elsewhere with very dark slate brown scales. Tongue luteo-fuscous, edged ex-

ternally with fuscous, the tip slightly paler; the papillae (61:51) slender, rod-like, slightly largest in the middle, each separated from its neighbor by nearly its own length, about five times as long as broad and shorter than half the maxilla breadth, with six or eight vertical ribs terminating above in long produced points or bristles, as long as the central filament.

Thorax entirely covered above with very long, mouse brown hairs, those of the prothoracic lobes and patagia tinged faintly with olivaceous, those at the posterior portion of the thorax still more slightly with faint bluish; beneath covered with silvery gray hairs. Femora covered with iridescent pearly white and dark brown scales, the former greatly predominating, the latter more prominent next the lower edge; this edge is rather broadly fringed with very long mingled grayish white and brownish hairs, much longer on the outer than on the inner half, and decreasing in length toward the apex; tibiae covered with pearly white scales with intermingled blackish brown scales, scattered especially upon the upper surface and forming a rather large patch near the apex; spines black; spurs reddish, tipped with black; tarsi similarly covered above and on the sides with white scales, occasionally relieved by black scales, which, on the upper surface and sometimes on the sides, form black spots situated at the base of each joint and near the apex of the basal joint; they are so large as to leave only a narrow, transverse band of white scales; under surface yellowish brown; spines black; claws reddish.

Wings above uniform, blackish brown in bred, grayish slaty brown in captured specimens; either with the faintest possible indication of one or two small, submarginal, dull orange spots next the anal angle of fore wings (δ); or with two or three more frequent and larger similar spots; sometimes also tinged faintly with dull orange on the apical half of the fore wings, and especially on its lower portion (η); extreme costal edge of fore wings delicately fulvous; both wings edged externally with a delicate purplish or brownish black line, the fringe slate brown, but next the anal angle of the hind wings, as far as the lower median nervule, white in the middle; inner border of hind wings with intermingled grayish white and brownish hairs. Discal spot on fore wings of male rather regularly obovate, fully twice as long as broad, about 2.25 mm. long, grayish brown, paler in worn specimens.

Beneath uniform, soft, slaty brown with a silky lustre (in other than bred specimens sometimes delicately and faintly tinged with violaceous), spotted with black, red and white, the fringe and edging of the wings as on the upper surface. *Fore wings* with a somewhat irregular, transverse row of seven velvety black spots, narrowly edged externally with white, lying nearly midway between the middle of the wing and its outer border; the upper three in a straight or slightly curving row, one on either side of the inferior subcostal nervule, and one in the apical subcostal fork; these are smaller than the rest, generally round, sometimes lunate, and there is occasionally a fourth, a dot, in the next interspace above; the two succeeding spots are largest, transversely ovate or occasionally lunate, and lie parallel to the upper half of the outer border, the exterior edge of the upper spot on a line with the interior edge of the spot above; the two lower spots, in the next interspace below, may perhaps be considered as one divided spot; they lie at the same distance from the outer border of the wing, but a little within the direction of the two largest spots, and are sometimes obsolete. Between this row of spots and the outer border, but nearer the latter and following its curve is a row of five or six black lunules, increasing in size below, opening outward and partially enclosing, externally, deep orange spots of variable shape, but usually of a uniform size; sometimes, however, either the black or the orange is obsolescent, and generally, the black predominates in the male, the orange in the female; the spots are in the same interspaces as those of the previously mentioned row and the lower is double in conformation but not in size; the upper spots are sometimes obsolete. *Hind wings* with the discoidal cell closed by a narrow streak of black scales, faintly edged exteriorly with white; like the fore wings, they have two series of spots, the inner row consisting first of six roundish black spots, narrowly edged with whitish scales, especially on the outer side, a little larger than

the upper spots of the inner row on the fore wings and situated on succeeding interspaces in pairs; the second pair are in the interspaces beyond the cell and are subparallel to its limiting black streak (the lower spot the outermost) and lie midway between it and the outer border; the upper pair are on a line with a point midway between the discoidal streak and the second pair, but not quite parallel to them; the lower pair in the median interspaces are on a line with the upper pair; the remainder of the row, when not obsolete, as it has a tendency to become in the male, consists of two transverse streaks, edged, like the spots, with white: the first straight, bent, waved or curved, but usually with a direction subparallel to the discoidal streak, but broader than it and crossing nearly the whole of the medio-submedian interspace, its outer edge either nearly continuous with the interior edge of the lowest pair of spots (δ), or partly or wholly on a line with the discoidal streak (φ);* the second, in the succeeding interspaces, is always bent, the limbs straight, the upper third nearly on a line either with the streak above (δ) or with the discoidal streak (φ), the other portion bent inward nearly at a right angle and contiguous to the inner border of the wing. Beyond this row is a submarginal series of eight large, roundish, deep orange spots, usually larger in the female, situated in the same interspaces as the spots of the inner row, each spot bordered interiorly and, to a less extent, exteriorly by a bent, often angulated, slender, black streak, surmounted, especially interiorly, by a few pearly white scales; the two spots next the anal angle are usually confluent and the slender space between the black exterior edging and the black line bordering the whole wing is mostly filled with a mixture of pearly white and brownish scales.

Abdomen covered with soft, slaty brown scales; beneath yellowish gray. Alations of upper organ of male (34:23) with nearly squared upper and posterior edges, the latter produced below into a slight angular lobe; lappet of inferior edge longer than broad, well rounded; clasps beyond the gibbous portion tapering regularly to a fine point; this lamina not so long as the basal portion, half as broad and less than three times as long as broad.

Measurements in millimetres. Length of tongue, 5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	13.5	15.	16.5	12.5	15.5	16.
antennae.....	7.5	8.25	9.	6.5	7.75	7.75
hind tibiae and tarsi.....	4.5	5.	5.25	4.25	4.5	5.25
fore tibiae and tarsi.....	3.5	3.75	3.75	2.75	3.25	3.5

Male specimens from Iowa and Minnesota differ from all others that I have seen in having the spots of the inner row of both wings much larger, being nearly half as large as the submarginal spots of the hind wings.

Secondary sexual peculiarities. The male stigma is mentioned in the description of the wing, as is also the remarkable difference in the contour of the wings in the two sexes. The scales found in the stigma (46:27) are regularly and gently tapering, broadly rounded at base, truncate with slightly rounded angles at tip, more than four times as long as the median width. Length of lamina, .11 mm.

Egg (65:11). Deep green, the projections whitish, giving a hoary bloom to the egg. The projections are about .065 mm. apart, and where highest as on the outer walls, nearly half as high as that; at the base the coarse cell walls continue a short distance after the projections have altogether ceased, making coarse triangular cells, but fully half the diameter is free of markings; above, the projections slightly decrease in size as the micropyle (68:4) is approached and suddenly stop at its edge, leaving a circular pit .16 mm. in diameter, filled with a delicate tracery of polygonal cells about .015 mm. in diameter. Diameter of egg, .9 mm.; height, .5 mm.

Caterpillar. First stage. Head jet black; mouth parts pale brown; tips of mandibles black. Body pale brown, delicately shagreened with fine black points; the lozenge-shaped shield of the first thoracic segment slightly darker, infuscated around the

*These sexual differences are due to the differing form of the anal angle in the sexes.

edges. Before the end of this stage short, pale green, oblique bars, occupying each a segment, begin to show faintly as markings on the more pallid surface, and a more distinctly green dorsal stripe begins to appear. Papillae white, conical, elevated, pale brown with a dark brown apex. Hairs tapering minutely and very spiculiferous, white or pellucid. Lenticles hemispherical, white, ringed with brown. Prolegs color of body, legs slightly infuscated, especially toward the tip. Length, 1.3 mm.; breadth, .4 mm.

Second stage. Head shining pale greenish testaceous, heavily and broadly infuscated below; beneath this pallid, the labrum again infuscated. Body pea green, with pale, slender, dorsal, laterodorsal and ventrostigmatal stripes and, running from above backward and downward parallel to each other, similar oblique bars, connecting the longitudinal stripes, each crossing the whole of two segments, scarcely interrupted at the sutures. Moderately long, backward curving, very pale brown, spiculiferous hairs in the laterodorsal region, three or four on each segment on either side and similar long curving hairs in the ventrostigmatal region, besides very sparsely scattered, shorter, spiculiferous hairs over the whole body; the longer ones seated on stellate papillae; skin punctulate like a thimble-head, very closely resembling the surface of the cherry leaf. Beneath pallid. Length, 3.5 mm.; breadth, .9 mm.

A specimen apparently in this stage was described by Mr. Saunders as having a brownish black head, a dull rosy red body of a brighter tint, with the edges of the dorsal crest paler.

Fourth stage. Head shining black, with a pale stripe across the lower margin of the front; mandibles black. Body above green along the middle segments, deep rose color at each extremity, thickly covered with short brown hairs; the first thoracic segment rosy above, greenish yellow at the sides and as an edging in front; second thoracic segment entirely rose colored; beyond falls a wide dorsal stripe of rose, reduced almost to a line on the second and third abdominal segments, widest on the last thoracic and first, fourth and fifth abdominal segments, and terminating on the sixth; on this segment the green encroaches on the rose color on the sides of the body and behind it the body is rose color with a darker dorsal streak; a substigmatal rosy line along the fold. Under surface dull green with a yellowish tint; legs and prolegs yellowish green. Length, 10 mm. (After Saunders.)

Last stage (75:35). Head shining black, with a dull white streak across the lower margin of the front; mandibles reddish brown. Body above dull green with a yellowish tint especially anteriorly; a dorsal dark green stripe on thoracic segments; a patch of dull pink or rose color on the thoracic segments, faint on the first and covering but a small part of its upper surface, nearly covering the dorsal area on second, and on third reduced again to a small faint patch; posteriorly a much larger rosy patch from the fifth abdominal segment posteriorly; on the fifth it merely tinges the hinder part of the segment, on the next it is enlarged to a considerable patch widening posteriorly, and behind this the whole upper surface of the body is rosy red; the substigmatal fold is also rosy on the fifth and sixth abdominal segments. Under surface yellowish green, with a few very fine brownish hairs. Above covered also with very short brown hairs arising from minute, pale yellowish papillae. Legs and prolegs transparent green. Length, 18 mm.; breadth, 5 mm. (After Saunders.)

Chrysalis (84:37). Pale brown and glossy with many small dark brown or blackish dots distributed over the whole surface, more abundant along the middle above, appearing as a faint, imperfect stripe from the third to the seventh abdominal segments; surface thickly covered with very short brown hairs. Length, 11.5 mm.; width, 5 mm. (After Saunders.)

Distribution (23:1). This butterfly is found over a wide extent of country, crossing the continent in a broad belt which includes most of the United States. The southernmost localities from which it has been reported are Georgia "very rare" (Abbot), Alabama (Gosse), Missouri

(Edwards), Texas (Belfrage), New Mexico and Arizona. In the north it occurs as far as the southern boundary of the Canadian fauna and beyond, for it has been taken at Montreal rarely (Fyles, Lyman, Caulfield), at Ottawa (Fletcher), in the Adirondacks of New York (Hill), at London, Ont. (Saunders), and even at Nepigon (Fletcher); while west of Lake Superior and east of the Rocky Mountains its northernmost localities known are New Jefferson (Allen) and Des Moines, Iowa (Austin), Minnesota (Scudder), Manitoba (Fletcher), Dakota (Morrison), Montana (Coues), Regina, Assiniboia (Fletcher), and Old Man's River, Alberta (Geddes). In the Rocky Mountain region it has been taken in Colorado by Ridings, on the Ute Pass road to South Park (Snow) and at Apex Gulch and Bailey's Ranch (Mead); besides in New Mexico and Arizona, already mentioned, and in the Big Horn Mountains (Edwards). West of the mountains it is only known from the observations of Mr. Henry Edwards, who has taken it in northern Oregon (Portland, Dalles) and Vancouver Island.

In New England it is considered a rare insect, but has occasionally been found in considerable numbers and is well distributed, at least over the southern portion. The only northern locality in which it has been found is Norway, Me., where it occurred in abundance (Smith). In the southern half it has been taken at Portland, Me., Milford, N. H. "not common" (Whitney); in Massachusetts, at Williamstown (Scudder), Springfield "not uncommon" (Dimmock, Emery), Mt. Tom (Emery), Holyoke Range (Parker), Amherst (Merrill), Belchertown and Leverett (Sprague), several localities in the vicinity of Boston "very rare" (Faxon, Sprague, Scudder), Walpole (Guild), and on Cape Cod at Hyannis (Scudder), Sandwich (Bethune, Fish), Eastham (Fish), and Provincetown (Sanborn); there are specimens in the Yale College Museum from Guilford, and it has been taken at Farmington, Conn. (Norton).

Haunts. The butterfly frequents blossoms, especially those of golden-rod (*Solidago*, — Sanborn, Scudder), Jersey tea (*Ceanothus*—Lintner), milk weed (*Asclepias*—Saunders) and thistle (*Cnicus*—Fish). Abbot says his specimens were found in oak woods, frequenting the blossoms of redbud (*Cercis*); it usually occurs about flowers in the most open places, exposed to the fullest rays of the sun. Mr. Allen especially states that in Iowa it is "found on the edges of prairies by the woods—not in the woods themselves," and in the east it generally occurs in the neighborhood of thickets.

Oviposition. The only egg I have seen was found tucked into the angle made at the extreme tip of a wild cherry twig by the equal forking of two little shoots, so that it was difficult to tell which should be called the terminal shoot.

Food plant and habits of caterpillar. Abbot states that the larva

figured by him as belonging to this insect "feeds on the flower figured, oak, etc." The flower is *Eupatorium coelestinum* Linn., a composite plant, and a highly improbable food plant for such an insect, which has since been found in several instances upon wild cherry, and reared by Mr. Saunders on plum leaves, which the caterpillar seemed to prefer to cherry. It is far more probable that its food plants will be found limited to Rosaceae and perhaps Cupuiferae.

In leaving the egg the caterpillar eats a circular hole through the top, large enough to crawl out easily, and at once makes its way to the half-opened leaves close at hand; here it eats circular or oblong holes on either surface of the leaf, having a larger diameter of about one millimetre, down to the opposite membrane of the leaf, which it does not pierce. The under surface of the leaf is usually chosen, as indeed is almost necessary, as it hatches at a time when the leaves are not expanded or only expanded a little, and in the first instance still remain with their normally upper halves closely appressed. Later, while still in its first stage, and the leaves have opened, the caterpillar occasionally resorts to the upper surface, and now, on whichever surface, ploughs short, irregular, jagged tracks through the parenchyma, down to the membrane, and even occasionally at the very end of this stage, completely through the leaf. This stage occupies about ten days, and is passed entirely upon the leaf it first attacks. It should be noted that the hairs of the under side of the wild cherry leaf closely resemble the bristles of its own body at this stage.

When about to moult for the first time, it bites away these hairs over a space large enough for it to get its whole body down to the floor of the leaf itself, and there sits and mopes till the time comes.

On disturbing a caterpillar past the first moult, it will thrust its head out to its fullest extent, attach a thread to the surface, and then, arching its body, let go all hold by legs or prolegs, and hang by the thread it has spun. By degrees it then lowers itself by extending the thread until it reaches the ground, where it remains motionless for a time, and then crawls away.

Life history. The butterfly passes the winter in the egg state. The eggs hatch just as the foliage of the wild cherry begins to open, about the middle of May. It does not reach maturity before the last of June, remains in the chrysalis twelve days, and first emerges from the chrysalis shortly before the middle of July. The period of its earliest abundance is the last of July and the first of August, the advent of the female being, it would seem, usually delayed until the 20th or 25th of July, although Mr. Saunders reared one as early as the 13th. It continues upon the wing until nearly the last of August, and doubtless lays its eggs throughout this month, and these remain unhatched until the following spring. The only departure I find from this general statement is the capture of the

butterfly by Mr. Lintner at Bethlehem, N. Y., on June 22, and at Centre on July 9; and by Mr. Sprague at West Roxbury, Mass., on July 3. In the south the only dates of capture are those of Gosse in Alabama, July 1, and Abbot, who bred the butterfly on May 5, after seventeen days in the chrysalis, and records a capture on May 26.

Desiderata. Thanks mainly to Mr. Saunders, our history of this species is nearly perfect: but we still need a fuller account of the larval stages, and especially of the variation which doubtless occurs; for Mr. Saunders's description of the mature larva differs remarkably, as he has pointed out, from Abbot's illustrations. The food plant *Eupatorium* is properly challenged and should be inquired into by practical applications to the caterpillar. The details given above concerning the apparition of the imago are based on scanty material, and the reason for its long flight-time (nearly three months) should be explained. The distribution of the insect in the southern and western states, and through the central portions of New England is very little known, and we altogether lack any report upon its flight, postures and parasites.

LIST OF ILLUSTRATIONS.—STREYMON TITUS.

General.		Imago.	
Pl. 23, fig. 1.	Distribution in North America.	Pl. 6, fig. 24.	Male, both surfaces.
Egg.		26.	Female, both surfaces.
Pl. 65, fig. 11.	Plum.	34: 23.	Male abdominal appendages.
68: 4.	Micro-pyle.	39: 15.	Neuration.
Caterpillar.		46: 27.	Androconium.
Pl. 75, fig. 35.	Full grown caterpillar.	55: 4.	Side view with head and appendages enlarged, and details of leg structure.
Chrysalis.		61: 51.	Papilla of tongue.
Pl. 84, fig. 37.	Side view.		

ERORA SCUDDER.

Erora Scudd., Syst. rev. Amer. butt., 32 (1872). *Thecla* (pars) Auctorum.
Type.—*Thecla taeta* Edw.

Amongst the rainbow butterflies,
Before the rainbow shone.

MARY HOWITT.—*The Hummingbird*.
Or shooting upwards through the light
With arrowy motion silvery bright,
The silent summer air employ
For their region of capricious joy!

Hogg.—*The Poetic Mirror*.

Imago * (55: 2). Head moderately large, densely clothed with scales and rather thinly furnished with not very long hairs, arching forward above, curving downward in front. Front apparently† less than half as high again as broad and as broad as the front view of the eyes. Eyes rather large and full, thinly and, especially above, rather bristly pilose. Antennae inserted in front of the middle, rather widely separated. Antennae composed of twenty-five joints of which the last ten form a slightly

* Characters drawn mostly from the female. † No denuded specimen examined.

compressed subcylindrical club, abruptly and almost equally rounded at either extremity, equal throughout most of its length, the first two and last three joints diminishing in size, the last joint very slightly pointed at the apex; the club a little more than one-third the length of the stalk, viewed from above twice, or viewed laterally three times, as stout as the stalk and, viewed laterally, six times as long as broad, the last two joints wholly naked, the others only naked beneath.

Palpi short and slender, but little longer than the eye, the terminal joint about three-fifths the length of the penultimate and clothed only with recumbent scales, while the other joints, besides being heavily scaled, are furnished beneath with a rather heavy fringe of pretty long, forward reaching hairs, all compressed in a vertical plane.

Fore wings (39:17) two-thirds as long again as broad, the costal border slightly convex on the basal third, beyond straight nearly to the tip where it is rounded a little, the outer border nearly straight on the upper two-thirds, receding with a gentle curve below, its general course at an angle of about 55° with the middle of the costal border; inner border nearly straight, scarcely concave or bent at the middle, its outer angle well rounded.

Costal nervure terminating opposite the end of the cell. Subcostal with three superior branches, the first arising a very little beyond the middle of the cell; the second about midway between this and the apex of the cell, the third a little more than half way between the second and the tip of the cell, the main stem hardly flexed at the cross vein connecting the inferior nervure with it and the median, the last only distinct next the main veins, the inferior nervure arising from its middle. Cell slightly more than half as long as the wing and three and one-half times longer than broad.

Hind wings with the costal border greatly, suddenly and roundly expanded at the base, beyond scarcely concave, until toward the tip where it is broadly rounded without sign of angulation; outer border very regularly and considerably rounded; inner border rather slightly and regularly bowed, the outer angle not rounded, more than a right angle; submedian nervure terminating on the outer border just beyond the anal angle; internal nervure terminating somewhat beyond the middle of the inner margin.

No discal stigma nor androconia.

Fore tibiae about four-fifths the length of the hind tibiae, and rather shorter than the fore tarsi. Femora thinly fringed with long hairs. Middle and hind tibiae of about equal length, armed at the tip with not very long spurs, concealed almost to the apex with scales. First joint of tarsi a little shorter than the others combined, the second nearly as long as the third and fourth together, and a little longer than the fifth; joints rather abundantly armed on either side beneath with moderately long and slender spines, the apical ones of each joint longest; under surface of all the joints but the basal devoid of scales; claws very small, compressed, tapering, curved only a little, finely pointed; paronychial single, rather broad, compressed, tapering a little, curved slightly toward the claw and also inward; pulvillus minute, projecting.

Egg. Regularly echinoid, more than twice as broad as high, more flattened beneath than above, broadest below the middle, the surface profusely studded with elevated conical points, with five lower stellate rays diverging from them toward all neighboring points, forming everywhere a pentagonal reticulation, the cells of which are extremely small, smaller than in any other of our Theclidi. Micropylar area flattened, but not sunken.

This American genus of Theclidi is better represented south of our boundary than within it, at least two species being found in Mexico and Central America. Our own species has been found in abundance only in southern Arizona, and apart from that has a very anomalous distribution, being only known in the northeastern United States by a specimen captured here and there.

The butterflies are very beautiful and the sexes differ in coloration above. Their wings are pretty well rounded, destitute of tails; they are dark brown above, all the hind wings excepting the costal margin (female), or only the middle portion of their outer border (male), metallic blue; beneath they are of a duller blue, the fore wings partially traversed in the middle of the outer half by a series of connected reddish spots, the hind wings with a submarginal series of independent spots and an extramedial, tortuous stripe of the same color.

They seem to appear on the wing twice in the year, in May and July, and hibernate in the chrysalis state. Nothing more is known of their history than is gained by the few dates of capture of the imago.

EXCURSUS XXVII.—THE BEST LOCALITIES FOR COLLECTORS; FAVORITE BUTTERFLY HAUNTS.

Oh! the bonny, bonny dell, whaur the primroses wonn,
Luikin' oot o' their leaves like wee sons o' the sun;
Whaur the wild roses hing like flickers o' flame,
And fa' at the touch wi' a dainty shame;
Whaur the bee swings ower the white-clovery sod,
And the butterfly flits like a stray thought o' God;
Whaur, like arrow shot frae life's unseen bow,
The dragon-fly burns the sunlight throu!
Oh! the bonny, bonny dell, whaur I sang to see
The rose and the primrose, the dragon and bee!

MACDONALD.—*The Bonny, Bonny Dell.*

MOUNTAIN valleys, in my experience, are the best localities for securing butterflies in number and diversity. Their plentiful moisture, and perhaps more than normal midday warmth, with their diversity of surface render them favorable places for abundance and richness of plant-life, upon which of course butterfly existence depends. It does not, however, follow that diversity of flora is correlated with variety and abundance of butterfly life. The island of Nantucket, for instance, has a very diversified flora, and tame as is the aspect of the somewhat monotonous surface of the island, it is everywhere clothed with verdure except upon the seashore or the steeper parts of its bluffs. Yet its butterfly fauna is essentially meagre and comparatively uninteresting. River bottoms support a luxuriant vegetation, but unless the surface is broken or varied by groves with openings partly filled with shrubbery, the butterfly fauna will not be greatly varied; for next to mountain valleys for variety and abundance, their miniature representatives, the ravines among the hills, will be found the most attractive resorts; here the little streams favor the growth of copses, and by their twists and turns have so moulded the forms of the surface as to offer nooks where the breezes may waft the but partly willing butterfly into a haven of delight with others of his kind; where flowers of some sort are always in bloom to satisfy the appetite and the quiet air permits them to open their wings softly to the warm sun.

Old and not too extensive cultivated clearings in the forest district, approached by a highway through the forest are choice spots, but such are becoming rarer every year, and must be sought in comparatively new country. Wallace found the same true in Brazil. "I have invariably found," says he, "that in an open path through the forest the chequered light and shade causes a variety of plants to spring and flowers to blow, which in their turn attract a great variety of insects. An open pathway seems to have similar attractions for many kinds of insects to what it has for ourselves. The great blue butterflies, and many smaller ones, will course along it for miles, and if driven into the forest, will generally soon return to it again. The gleams of sunshine and the free current of air attract some; others seek the blossoms which there abound; while every particle of animal matter in the pathway is sure to be visited by a number of different species." (*Travels on the Amazon*, 170.)

Yet he who would content himself with these places, where the abundance of life is forced upon his notice, would fail to obtain many sorts that appear to visit but rarely or even to shun such choice spots. Many frequent the open meadows or even favor the dry pasture; others follow the tangle which grows by fences and walls in the country or skirt the edges of woods; others seek the depths of open deciduous woods, especially before the foliage is full-leaved; while not a few vastly prefer the hill-tops open to the sky; marshes claim some kinds, and even rocky ledges are the unlooked for home of others. It is only the adventurous lover of nature in all her moods who will make the best aurelian.

It takes a long time to exhaust all the possibilities of a given district, but a good entomologist soon discovers most of the choice spots. It is well, therefore, to take counsel of a local spirit, and put oneself under his guidance. Successive generations of hunters hand down the sanctity of certain special spots, but with the rapid and wholesale changes wrought upon the face of the land by our irreverent civilization, these often become mere traditions. It may, however, be well to notice one or two New England localities. Mention has been made elsewhere of the White Mountains as a home for butterflies, and of the special attractions of the Glen, and it is not necessary to do more than to allude to them. The nearest approach elsewhere to such spots may be found in the Hopper, the deep, open-mouthed ravine on the westerly side of Graylock in Massachusetts, where at an elevation of not far from a thousand feet above the sea a very similar fauna occurs, but with less profusion of individuals. It has never been properly hunted and would certainly well repay a summer's residence in one of the two or three farm houses found there, especially if residence began with the first outburst of vegetation. There must also be many a similar but lesser ravine or pass in the Green Mountains and in the hill-district of New Hampshire, in the broken country of western

Massachusetts, in that part of the Connecticut valley where the river passes between Mts. Tom and Holyoke, as well as in other sections of the triassic traps of this valley which here find their culmination. In northern Maine, with its vast forests, one is dependent on the clearings and the older logging roads near open water, and the mountain elevations are not so full of resources as elsewhere. Princeton, Mass., with its elevated meadows, broken surface, abundant flowers and breezy hillsides and its proximity to Wachusett is one of the best localities in New England. Amherst in the same state is favorably situated, and so are several towns in New Hampshire which Monadnock overlooks. Indeed whenever a local collector of enterprise and spirit is to be found, it would almost seem, from the variety of his captures, as if his were a particularly favored locality. I doubt indeed, if there is a spot in New England (unless we except the heavily wooded unsettled parts of northern Maine which are not likely to be favored in many a year with the presence of a local entomologist) where it would not be easy in a single summer to obtain within a radius of ten miles one-half the nominal species of all New England; and there are not a few in which more than one hundred species have been secured. About Boston the choicest localities are the less settled districts about the Blue Hills, Prospect Hill in Waltham, the region about Waverly and the Middlesex Fells.

ERORA LAETA.—The spring beauty.

[The spring beauty (Scudder); blue streaked butterfly (Maynard).]

Thecla laeta Edw., Proc. Acad. nat. sc. Philad., 1862, 55-56, pl. 1, figs. 1, 2 (1862);
Butt. N. Amer., 1, *Thecla* 1, figs. 1-4 (1869);
—Fern., Butt. Mo., 85-86 (1884);—French,
Butt. east. U. S., 277-278 (1890);—Mayn.,
Butt. N. E., 37-38, pl. 8, figs. 47, 47 a (1886).

Erora laeta Scudd., Syst. rev. butt., 32 (1872),
Thecla clothilde Edw., Proc. Entom. soc. Philad., ii: 15 (1863);—Scudd., Proc. Bost. soc. nat. hist., xi: 377 (1868).
Figured by Glover, Ill. N. A. Lep., pl. II, fig. 7; pl. M, fig. 9, ined.

Full many a Ladie faire, in Court full oft
Beholding them, him secretly envide,
And wisht that two such faines, so sikken soft,
And golden faire, her Love would her provide;
Or that, when them the gorgeous Flie had doft,
Some one, that would with grace be gratifide,
From him would steal them privily away,
And bring to her so precious a pray.

SPENSER.—*Muirpotsmos*.

How would, I say, mine eyes be blessed made
By looking on thee in the living day.

SHAKESPEARE.—*Sonnet*.

Imago ♀: 6, 9). Head covered above with shining dark olivaceous scales, mingled with a few buff ones, the base of the antennae surrounded by black scales and between them a loose cluster of white scales; the usual slender rim of snow white scales surrounds the eye and the front is filled between them with blackish brown

scales, mingled down the middle with a loose cluster of pale greenish blue scales. Palpi with the basal and middle joints covered outwardly and beneath with white scales, flecked, especially toward apex, with a few blackish ones, and with frequent black bristles beneath; within and above blackish brown flecked sparsely with white; apical joint blackish brown, marked with white beneath and at base above. Antennae blackish brown with a purplish tinge, the outside of the basal joint marked with white and the base of all the joints of the stalk and of the base of the club rather broadly annulated with white; two or three of the apical joints of the club wholly orange; the others dusky beneath, sometimes tinged with orange; tongue blackish fuscous, dark luteous at extreme tip.

Thorax covered above with mingled dark and light brown hairs, becoming tawny on the prothorax and excepting there mingled rather profusely with light metallic blue scales; beneath white with a pale bluish tinge, giving a silvery blue appearance, broadly annulated on the femora and basal part of tibiae with dark brown on distal part of tibiae and on tarsi with black; under surface of tarsi wholly dull luteous; spines and claws dark reddish.

Wings above blackish brown, scarcely and irregularly mottled with gray brown. *Fore wings* having the costal edge dark orange buff and the outer edge blackish, the base of the wing with a few bluish gray hairs, the surface either uniform, with a few inconspicuous dull greenish blue scales on the basal half of the wing below the cell (δ), or sprinkled profusely with dark metallic blue scales next the base, forming a brilliant patch, extending from the subcostal nervure to the inner border and limited outwardly by a line running from the middle of the upper border of the cell to the base of the last median nervure, thence to the middle of the lower median nervure and thence to the inner border crossing the nervules at right angles (ϕ); fringe pale buff, becoming mingled below with griseous and at the extreme base orange buff more or less obscured with griseous. *Hind wings* with the outer edge blackish and the wing covered profusely with dark metallic blue, either confined to a patch about as broad as an interspace, resting on the blackish margin of the outer border between the upper median and internal nervures and including minute, faint dusky spots in the middle of the interspaces (ϕ); or occupying the whole wing, excepting the inner border as far as the submedian nervure, and a broad belt on the costal and outer margin separated from the blue field by a nearly straight line, which extends from close to the base of the costal margin, crossing the subcostal nervure close to its divarication and directed toward the outer border at the middle of the subcosto-median interspace; just before reaching the outer border, however, it bends to the tip of the upper median nervure and sends also a faint shoot of dusky scales back upon that nervure; minute, faint, dusky, submarginal spots are found in the blue field in each of the interspaces, growing less distinct toward the anal angle (δ); the anal angle is marked inconspicuously with reddish orange and the fringe at this point is of the same color; elsewhere it is pale on the apical half, largely obscured with griseous on the basal half, but enlivened in this part with more or less frequent, dull, reddish orange scales.

Beneath, greenish silvery gray. *Fore wings* with the costal margin flecked with reddish orange scales; crossing the middle of the outer half of the wing is a series of reddish orange, quadrate, slightly transverse spots, bordered within faintly, without distinctly but narrowly, with black, followed in the latter case by a similar edging of white scales; the series consists, first, of a nearly straight row of five spots, one in each consecutive interspace above the lower median nervure, the next to the upper spot sometimes removed a little inward but usually all forming a slightly curved band, directed from the middle of the outer half of the costal border to the middle of the outer four-fifths of the lower median nervure; and second, of a similar obsolescent (in the δ always obsolete?) spot, transversely linear and almost wholly made up of only the black and white bordering; fringe dull reddish orange, paler on apical half, above and below largely obscured with fuscous, especially at tip. *Hind wings* with two rows of spots similar to those of the fore wings; the inner row consists of sub-

continuous spots forming a tortuous narrow stripe, with no interior black bordering; it is usually continuous only from the upper subcostal to the upper median nervules, and its course is as follows: it crosses the costo-subcostal interspace at its middle; the upper subcostal further out, in the middle of its basal two-thirds; the next interspace just below this and the following removed outward by its own width; the upper median interspace at the very base and the lower on a line with the spot of the subcosto-median interspace; the interspaces below, again as a slightly curved or sinuous stripe, on a line with the spot in the upper median, and in the middle of the medio-submedian interspace; the outer series of spots is pretty regularly arcuate, subparallel to the outer border and removed from it by about the width of an interspace, that in the upper half of the medio-submedian interspace a little further from the base; the spots are small, triangular, or sometimes rounded, decrease in size upwardly above the lower median, are found in each interspace below the upper subcostal nervule and are faintly and narrowly bordered with mingled black and whitish scales, the black seldom present on the sides; the wing is slenderly edged with a pale line bordered exteriorly with blackish and the fringe is reddish orange at base, pale at apex, and below tipped with black. Abdomen black above tinged with pale blue and pale brown on the sides; beneath whitish or silvery gray. Appendages not studied.

Measurements in millimetres. Length of tongue, 3 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore-wing.....		10.8		10.2	10.5	10.5
antennae.....				5.2	5.2	5.2
hind tibiae and tarsi.....	3.		3.	3.	3.	3.
fore tibiae and tarsi.....	2.		2.	2.	2.	2.

Described from 1 ♂, 3 ♀.

Egg (65:8). Pale pea green, the raised points hoary, about .03 mm. apart and about .02 mm. in height. Micropyle .1 mm. in diameter, consisting of about five unequal, kite-shaped, central cells surrounded by a crowded mass of pentagonal cells with their shorter axis about .01 mm. in length, directed toward the centre. Height of egg, .32 mm.; diameter, .72 mm.

Distribution (23:2). This is an exceedingly rare butterfly in the east, having been taken on very few occasions, but these show it to be widely spread. It has been found at St. Joachim, twenty-five miles from Quebec (Bowles), London, Ontario (Saunders), the Catskills, N. Y. (Edwards), Atlantic City, N. J. (Aaron) and Coalburgh, Kanawha Co., W. Va. (Edwards). Single specimens only have been taken at any one time. In the west, however, it has latterly come to light in considerable numbers on Mt. Graham, Arizona, some thousands of miles from its nearest known relatives.

In New England it has been taken in two localities in Maine, Streaked Mountain near Paris (Smith) and Orono (Fernald). On my last collecting tour in the Graylock Hopper at Williamstown, Mass., where I first began my chase for butterflies more than thirty years ago, musing over the butterflies whose early stages were unknown, my thoughts turned to the present species, and recalling thereby the lines I had already placed at its head in this work, I repeated them aloud, almost unconsciously. I had not gone half a dozen steps before I came to a damp spot in the road,

where *laeta* alighted at my very feet. Although it was the first time I had seen this charming object alive, I instantly recognized it; in another second my net was over it and I shouted triumphantly:—

How *have*, I say, mine eyes been blessed made
By looking on thee in the living day.

Life history. It is apparently double brooded, for the dates of capture appear to be too far apart, considering the freshness of the late specimens, to suppose them all to belong to one brood. The first brood appears in the north early in May; Mr. Saunders's specimens were taken in Ontario May 20 and 22, Professor Fernald's at Orono May 18, and Mr. Edwards's specimens in West Virginia, April 17 and very early in May. My specimen from Williamstown, a female and in excellent condition, was taken June 30, Mr. Aaron's from New Jersey, July 1, and Professor Smith's at Norway, on July 22, the last also in very good condition, and certainly not at all rubbed. The second brood must, therefore, appear late in June and in July, and the early appearance of the first brood indicates that the insect probably hibernates in the chrysalis state.

As to the haunts of this insect, all (unless the New Jersey specimen, and perhaps the London, be exceptions) seem to have been taken in mountainous regions. Mr. Saunders took his specimen in a wood; Mr. Edwards one of his at the bottom of a freshly dug post hole near a hop vine. Mine was taken on a road into a mountain ravine, just before it entered the woods from partially cleared ground.

Desiderata. Manifestly we know so little about this insect that every fact about it is desirable; first of all, as a guide to the rest, the food plant of the larva and the number of broods annually. I did not hesitate to sacrifice my specimen to obtain eggs, and placed the creature over wild herry, where she lived many days without laying, though her abdomen was full of eggs. The distribution and haunts of the insect make it probable that it will be discovered in a line across the country not far from our boundary with Canada, and in the Cordillera region north of Arizona.

LIST OF ILLUSTRATIONS.—*ERORA LAETA*.

- | | | |
|--|--|---|
| <i>General.</i> | | Pl. 14, fig. 9. Female, both surfaces. |
| Pl. 23, fig. 2. Distribution in North America. | | 39: 17. Neuration. |
| <i>Egg.</i> | | 55: 2. Side view with head and appendages enlarged, and details of the structure of the legs in the female. |
| Pl. 65, fig. 8. Plain. | | |
| <i>Imago.</i> | | |
| Pl. 14, fig. 6. Male, upper surface. | | |

INCISALIA MINOT.

Incisalia Min., Seudd. syst. rev. Am. butt., 31 *Lycus* (pars) Hübn., Verz. schmett. 74 (1816).
(1872). *Thecla* (pars) Aud.

Type.—*Lycus niphon* Hübn.

Upon his painted wings, the butterfly
Ran'd, a gay blossom of the sunny sky.

WILLIS G. CLARK.

Imago (55:1). Head small, densely clothed with scales and long hairs, arching forward or curving downward. Front nearly flat, very little swollen, but beneath a little tumid, barely surpassing the front of the eyes; above hollowed in a broad, shallow channel down the front; as broad as the eyes on a front view and varying in height from somewhat less to scarcely more than half as high as broad; upper border forming a distinct ridge in the middle, its angles considerably hollowed in front of the antennae; lower border strongly and rather squarely arched. Vertex almost perfectly flat, with a slightly raised ridge at the outer hinder portion of each antenna, and separated from the occiput by a very conspicuous, straight, transverse channel, deepest in the middle. Eyes rather large and full, rather densely pilose with moderate hairs. Antennae inserted with their hinder edge in the middle of the summit, separated by a space equal to or rather larger than the diameter of the second antennal joint, the basal joint naked; considerably longer than the abdomen, composed of thirty-two or thirty-three joints, of which from fourteen to sixteen form the club, which is elongated, cylindrical, depressed a little, nearly equal for most of its length, increasing in size only at its first two or three joints and on the last four or five diminishing rather gradually to a bluntly pointed apex, the apical joint being exceedingly minute; it is fully three times as broad as the stalk and about five times as long as broad. Palpi slender, about half as long again as the eye, the terminal joint about three-quarters as long as the penultimate and clothed with recumbent scales and a few hairs, the other joints furnished profusely with large, long scales projecting on the under surface but surpassed by a moderately heavy fringe of long hairs, all compressed in a vertical plane.

Patagia small, exceedingly long and slender, arched, and, excepting next the borders, tumid, a little more than three times as long as broad, the inner border nearly straight, the basal half narrowing slightly, the apical half equal, less than half as broad as the broadest portion, and terminating in a well rounded apex.

Fore wings (39:13) about three-fourths as long again as broad, the costal margin roundly and pretty strongly bent at a short distance from the base, beyond that straight, very slightly curved backward at the tip, the outer angle scarcely rounded; outer margin very slightly and regularly rounded, just above the middle of the wing a little full in the ♀, its general direction at an angle of about sixty or seventy degrees with the middle of the costal border; the inner margin straight, its outer angle slightly rounded; costal nervure terminating a little beyond the tip of the cell; subcostal with three superior branches, the first arising at or a little beyond the middle of the upper border of the cell; the second, two-thirds the distance from there to the origin of the third, which arises just before the apex of the cell; the main vein beyond the origin of the third is curved downward to meet the cross vein, either slightly and then continues in a straight course (♀), or pretty strongly and then springs back to resume its former straight course (♂); the cross vein is very feebly developed especially below; cell a little less than half as long as the wing and about three times as long as broad.

Hind wings with the costal margin strongly convex next the base, beyond nearly straight, outer angle variable, outer margin well rounded, very slightly prominent in the middle of the median region, at least in the ♀, the tips of the middle and lower

median nervules more or less slightly and roundly produced. Inner border rather strongly and regularly rounded, just before the tip considerably and roundly emarginate, leaving a rounded lobe at the tip, directed inward. Submedian nervure terminating on the outer border, just beyond the anal angle; internal nervure terminating just beyond the middle of the inner border.

Androconia ribbon-like, nearly equal throughout, with truncate apex, rounded at the angles, the base slightly lobed and the stem very short.

Fore tibiae about five-sixths the length of the hind tibiae, the tarsi equalling or exceeding the tibiae in length; the last tarsal joint either resembles the same part in the other legs ($\varnothing$); or it is small, tapering, curved and bears at its tip only a pair of nearly straight spines, the continuation of the row at the sides and is covered above with very short and close hairs (δ); otherwise, and excepting that in both sexes the tibial spurs are naked, these legs agree with the others. Femora rather thinly (fore femora thickly) fringed with very long hairs, especially in the male. Middle tibiae scarcely or not at all exceeding the hind tibiae in length, armed at the tip with a pair of rather long spurs, clothed with scales nearly to the tip. First joint of tarsi equal to the rest together (that of the hind leg tumid in the male), the others nearly equal, the second and fifth largest and equal, armed profusely on either side beneath with rather long, not very slender spines, the apical one on either side of each joint a little longer than the others; under surface of all the joints but the basal devoid of scales; claws small, compressed, strongly bent, with a curve at the middle, tapering, finely pointed; paronychii simple, nearly as long as the claw, broad and heavy, nearly equal; pulvillus minute, projecting.

Male abdominal appendages: upper organ rather large, but the alations rather small, separated, as viewed above, by a deep notch which is scarcely pointed at the extreme base; nearly circular, furnished with strongly recurved lateral arms which scarcely taper excepting at the finely pointed tip; clasps nearly straight, conical, rather rapidly and regularly tapering to a very finely drawn point, their lower edges subconnate nearly throughout.

Egg. Very depressed, cehinoid-shaped, as broad at summit as at base, studded profusely with prominent tubercles, each connected by six raised ridges to the neighboring prominences, disposed with considerable regularity in rows, but confused above, and with cells of lesser size. Micropyle rosette sunken but very little, rather large, composed of nearly uniform cells divided by slightly raised lines.

Caterpillar at birth. Head pretty well rounded, broadest and scarcely angular at the middle of the upper two-thirds, slightly broader than high. Body largest on the thorax, nearly equal on the abdomen as far as the posterior third, where it tapers to a rounded tip; flattened beneath a great deal, above flattened or hollowed a very little, the sides apparently sloping or even hollowed, the lower margin laterally produced; abdomen furnished with a laterodorsal series of very elevated slender warts, nearly uniform in thickness, two on each segment, emitting very long, erect hairs, curving pretty strongly, the convexity forwards, tapering and very minutely spiculiferous, giving the hair a frosted appearance under the lens; in the same series, immediately below, is an anteriorly placed small wart, one on each segment, bearing a backward directed stout hair, rather short, equal or a very little larger at apex than at base, the apex rounded and the apical half minutely spiculiferous. On the second and third thoracic segments all these hair-bearing warts become more and more distant from each other and are placed side by side instead of in a line; and on the second segment there is also a similar subdorsal pair. In addition, on the swollen basal fold of the body, there is another compound ventrostigmatal series of similar but not quite so elevated warts, bearing straight, tapering, smooth, laterally directed hairs; there is first a row of shorter hairs placed anteriorly, one to each segment; next and very close to it a row of hairs as long as the dorsal ones, one to a segment, placed centrally, and close to it a row of long hairs, two to each segment placed at equal distances from the edges of the segments; these are continued thickly all around the edge of the last abdominal segment. Besides the hair-bearing warts there is a

series of lateral or supralateral lenticles of a pretty large size though but little elevated, two to a segment, one larger anterior and a little higher than the other; the first thoracic segment bears a transverse anterior row of ten or twelve warts emitting long curving hairs and a laterodorsal pair of similar ones, all about half as long as the abdominal dorsal ones. Legs not very long, pretty slender, tapering regularly, the claws moderate in length, tapering, very little curved.

Chrysalis. Viewed from above the outline of the body is slender, subpyriform, hardly twice as long as broad, scarcely and very broadly hollowed along the posterior half of the thorax, the basal wing prominences scarcely perceptible, very broadly rounded in front, still more so behind. Viewed laterally, the hollowing between thorax and abdomen is very slight and gradual; the thorax is highest and equal on the posterior third, the front portion curving downward in the arc of a circle whose radius is about half as long as the body; the abdomen is highest and slightly higher than the thorax on the third segment, though scarcely higher than those in front on the succeeding two, their curve being very broad and low; behind, the abdomen falls in a very rapid curve, the whole of the eighth and ninth segments being nearly perpendicular, making the posterior curve of the body much more abrupt than the anterior. Transversely the middle of the thorax has an elevated arch, the sides obliquely compressed above and scarcely hollowed, the ridge well rounded; transversely the abdomen is very regularly arched, forming a nearly exact semicircle perhaps a very little compressed; half of the tongue exposed, the inner sides of the legs separated by it; basal wing prominence consisting of an exceedingly slight, low, broad, roundish elevation. Whole body covered equally with an interlacing, delicate, but very distinct network of raised lines, their points of intersection not raised but frequently enlarged and forming small round warts, similar to those which in the cells support the short spiculiferous hairs; the latter are of equal length over all the body. Hooklets short and very slender, the stem nearly equal and slightly curved, the expanded portion four times as broad as the stem, transversely ovate, the apical margin a little excised and toothed in the middle, the whole lobe bent suddenly over.

This is a purely North American genus, spreading across the whole continent between the annual isotherms of 60° and 45°. It is represented on either side of the Rocky Mountains by identical and perhaps also distinct species; all of the species of the eastern half of the continent occur in New England, two more abundantly in the south, one in the north. The group is represented in corresponding portions of the Old World by the closely allied genus *Callophrys*.

The butterflies are of medium or small size for Theclidi. The fringe of the hind wings projects slightly at the tip of each nervule, particularly at that of the lower median nervule; the extreme anal angle is slightly produced and bent downward at right angles; the wings are uniform dark brownish above, the disc of the female usually tinged more or less with a ruddy color. Beneath they are nearly as dark as above, especially on the basal half, which is separated from the outer by a tortuous line, occasionally rendered conspicuous by a bordering of white scales; a darker zigzag band, more or less distinct, crosses the outer half of the wing and between the two there is often a hoary field; the margin of the wing is filled with cloudy markings.

The butterflies are among the earliest, appearing in our latitude late in April or early in May, flying usually for little more than a month; the

males are almost always more numerous than the females, sometimes to a marked extent; the eggs hatch in about a week and thus before midsummer they are all in chrysalis, from which the butterflies do not emerge until the following spring; for all the species are single brooded, whether in the north or south. The history of the European *Callophrys* is identical. The transformations of all our species are known. The caterpillars feed upon Rosaceae, Ericaceae and Coniferae. The butterflies are not rapid fliers and on alighting, as they frequently do, the wings are held erect and the hinder pair immediately rubbed together up and down, with a slow irregular movement; this is common to both sexes.

The eggs are of a very depressed, echinoid shape, profusely studded with prominent tubercles, connected by ridges.

The juvenile larvae are furnished with a laterodorsal clustered series of long hairs, some tapering, nearly erect and curving, others equal, straight and directed backward; the ventrostigmatal fold has a somewhat similar clustered series of long hairs, which are microscopically spiculed.

The mature caterpillars are similar in general appearance to those of *Thecla*, the segments more moniliform, the body proportionately broader in front, and the laterodorsal ridge and ventrostigmatal fold furnished with hairs somewhat larger than those which cover the rest of the body. Their color is similar to that of the larvae of *Thecla*.

The chrysalids also closely resemble those of *Thecla*, and are of the usual dark brown color.

EXCURSUS XXVIII. — HABIT AS A GUIDE IN CLASSIFICATION.

Ah sim Papilio natus in flosculo,
Rosae ubi lillaque et violae patent;
Fioribus advolans, avolans, osculo
Gemmae tangens, quae saepe olent!
Regna et opes ego nequiquam postulo,
Nolo ego ad pedes qui se volutent—
Ah sim Papilio natus in flosculo
Osculans gemmas quae saepe olent!

Magisam si possem virgiam furari,
Alas has pulchras aptem nil, cheu!
Aestivis aetis diebus in aere,
Rosa cubans Philomelae cantu.
Opes quid afferunt? Curas, somnum rare;
Regna nil praeter aerumnas, cheu!
Ah sim Papilio, die volans aere,
Rosâ cubans Philomelae cantu!

Quemque horum vagulum dieis horrore
Frigora Autumni ferire suo:
Aestas quando ablit, mallem ego mori,
Omni quod dulce est cadente pulchro.
Brumae qui cupiunt capient labore
Gaudia, et moras breves trahunto—
Ah sim Papilio; vivam in errore,
Concidanque omni cadente pulchro.

F. W. [RANGHAM].

THE habits of butterflies are of extreme antiquity. They are ingrained into the very texture of their lives. They are older than, or at least as old as, the patterns which adorn their wings. Moreover butterflies have two sets of habits, and these statements are equally true of either. The habits of their earlier life as a crawling caterpillar find no place in their aerial life

on the wing, and vice versa; although in some we may find certain common characteristics shared by the two, as in the leisurely ways of the Satyrinae.

That this is true follows from the fact that certain special habits characterize large groups. Thus the mode of flight of the Satyrinae, which toss themselves lazily up and down as they move leisurely from spot to spot, is found to a greater or less degree in all the members of the subfamily; even in our White Mountain butterfly, which inhabits a place and is subjected to external conditions so different from the others; but it is not found elsewhere among butterflies. The caterpillars of this same group are universally slow in their movement, there being not a rapid traveller among them. All the caterpillars of the Nymphalidi hunch themselves, the better to display their largest tubercles. One of the most curious instances we may cite is the habit of rubbing the erect hind wings together shortly after alighting by all or nearly all the Lycaeninae, certainly by members of each of its three tribes, and so far as we know, it is done by no other butterflies. The darting, skipping flight of the Hesperidae is another instance, as well as the odd style in which the Pamphilidi hold their wings when alighted and alert, the hind wings horizontal, the fore wings vertical or oblique. Peculiarities of nest building are generally shared by a caterpillar with many allies, perhaps by the whole tribe to which it belongs. Slight tricks of movement, as of the sudden electric flitting of the wings when alarmed, or of the position of the antennae, are shared by many. This is equally true of the manner and place of alighting. Who ever saw one of the Lycaenidi settle instantaneously like a Pamphilid? How it doubts whether it has found the best place, or whether on the whole it will alight now or not!

So one might go through the whole catalogue of the ways and lives of butterflies to find that the great majority were ways and lives not of one but of many,—inherited traits, become fixed in their lives by constant repetition. Most frequently they are generic habits rather than specific, often tribal traits, or even subfamily tricks; this in itself shows that habit as a general thing must be older than the wing pattern. But if anything more were needed to show it, it would appear by the facts of mimicry, where pattern plainly shows a far greater pliancy to the summons of natural selection than can be affirmed of habit; and the numerous cases of protective resemblance tell equally the same story; here habit has often moulded pattern, or at most they have abetted each the other. As we must invariably discard the slightest notion of anything intentional on the part of the protected form, we cannot say, for instance, that the White Mountain butterfly alights on a gray rock, in preference to the ground or a twig of *Vaccinium*, in order to gain the protection afforded by the resemblance of the under surface of its wings to the mottled rock, but rather

that the protective coloring arose from its habit of alighting here, while the secondary habit of tilting the wings to heighten the mimicry *apropos* *pari passum* with the mottling.

If all this be true, a knowledge of the out-door life of our friends, both as crawling worms and as winged sylphs, may be of the utmost aid in attempts to note the interrelationships of nature; and these as well as features of actual structure must be accorded due weight in our classifications. But neither should be divorced from its fellow, and if in the present work I shall have done anything toward their proper combination and the just valuation of the two I shall have succeeded in one of my aims.

Table of species of Incisalia, based on the egg.

Cell walls coarse, obscuring and diminishing the cells.....	niphon.
Cell walls fine and clean cut, the cells well open.....	irus.
(Augustus not known.)	

Table of species, based on the caterpillar at birth.

Body pale green, marked with yellowish brown.....	niphon.
Body very pale greenish yellow.....	irus.
(Augustus not known.)	

Table of species, based on the mature caterpillar.

Body marked with lighter lines along the latero-ventral and substigmatal folds.	
The longitudinal lines white or whitish yellow, and so very distinct.....	niphon.
The longitudinal lines green, and so less distinct from the ground.....	irus.
No distinct longitudinal lines (at least none mentioned by H. Edwards).....	augustus.

Table of species, based on the chrysalis.

Abdomen heavily marked with black.	
Black markings of abdomen covering most of the surface above the spiracles.....	niphon.
Black markings of abdomen mostly confined to a narrow strip on either side.....	irus.
Abdomen with black markings only as small, rounded, disconnected spots on the sides.....	augustus.

Table of species, based on the imago.

Darker colors of the basal half of hind wings beneath distinctly limited on the inner side by a white or whitish edging.....	niphon.
Darker colors of basal half of hind wings beneath very indistinctly or not at all limited within.	
Outer half of hind wings more or less besprinkled, especially near margin, with pale blue scales, giving it a hoary bloom.....	irus.
Outer half of hind wings pretty uniform rust red, darkest next the margin.....	augustus.

INCISALIA NIPHON. The banded elfin.

[Brown butterfly (Abbot); niphon butterfly (Harris); banded elfin (Scudder); the pine Thecla (Packard); black and white banded-streaked butterfly (Maynard).]

Lienis niphon Hübn., Verz. schmettl., 74 (1816?); Zutr. exot. schmettl., II: 7, fig. 203-204 (1823).

Thecla niphon Boisdu-LoU., Lép. Amér. sept., 105-106, pl. 33, figs. 1-4 (1833);—Fitch, Trans. N. Y. St. agric. soc., 1837, 743-744 (1837); 4th Rep. nox. ins., 57-58* (1850);—D'Urb., Can. nat., v: 246 (1860);—Morr., Syn. Lep. N. Amer., 98 (1862);—Harr., Ins. Inj. veg., 4d ed., 278, fig. 107 (1862);—Saunders, Can. ent., i: 95-96 (1889);—Middl., Rep. ins. Ill., x: 94 (1881);—Pack., Ins. Inj. for., 201 (1881);—

Fern., Butt. Mo., 84-85 (1881);—Fletcher, Can. ent., xvi: 92-94 (1881); French, Butt. ent. U. S., 276-277 (1886);—Mayn., Butt. N. E., 36-37, pl. 5, figs. 45, 45a (1886).

Incisalia niphon Min., Scudd. Syst. rev. Am. buttl., 32 (1872).

Papilio plantus Abb., Draw. ins. Ga., Brit. Mus., vi: 55, fig. 173-175; xvi: 36, tab. 112 (ca. 1860).

Figured by Glover, Ill. N. A. Lep., pl. 28, fig. 7, pl. B, fig. 8, lined.

Not *Papilio plantus* Fabr.

What hand would crush the shken-winged fly,

The youngest of Inconstant April's minions,

Because it cannot climb the purest sky,

Where the swan sings, and the sun's dominions?

Not thine.

SHELLEY.

An embodied breeze at play.

MRS. HEMANS.

Imago (6: 21, 23; 13: 1). Head covered with rust-red scales and hairs, the occiput with dull olivaceous green hairs arching forward; eyes encircled, excepting above, by a narrow line of white scales; behind the eye inconspicuous and often backed by some black scales; in front extending up to and in front of the basal antennal joint, the two series connected just above the base of the tongue by a narrow line of mingled white and brownish scales. Basal joint of antennae blackish brown, naked, exposed; stalk black, tinged next the base with yellowish brown, each joint encircled very narrowly at the base with snow white scales, which on the under inner side expand into a considerable triangular patch; club velvety blackish brown, the last three or four joints luteo-ferruginous, beneath tinged with ferruginous, and at the base furnished with an extensive white patch. Basal and middle joints of palpi uniformly covered beneath with a heavy tuft of greatly elongated scales, snow white on the inside, speckled with mingled black, white and ferruginous on the outside; terminal joint not tufted, covered with mingled black, white and ferruginous scales. Tongue dark greenish brown, the basal third dirty luteous, the apex dull greenish yellow.

Thorax covered sparsely above with long and delicate dull olivaceous green hairs, brownish on posterior portion, the patagia inconspicuously edged with whitish scales, lying beneath the olivaceous scales; beneath, the thorax is profusely clothed with very long and delicate, mingled silvery gray, brownish and ferruginous hairs. Femora edged within with pearly white scales, on the outside and above with slaty brown scales, the lower surface and especially its edges furnished with very long, curving, mingled bluish white and ferruginous hairs, tibiae and tarsi covered with dark brown scales with many intermingled white scales, mostly confined to frequent narrow annulations; spines black; claws luteous, black tipped.

Wings above dark glossy brown with a ferruginous reflection; either the inner half of the posterior border is more or less brightly and extensively tinged with ferruginous (♂), or the outer two-thirds of each wing except the border itself deeply tinged with ferruginous, which blends gradually into the brown, and which is covered by lines of brown scales marking the veins (♀). The outer border of the wings is

* Pl. 3, fig. 6 is quoted, but I cannot learn that it was ever published.

edged with black, the nervules frequently black tipped; the fringe of the fore wings is blackish brown, interrupted at the middle of the interspaces with dull white, toward which the blackish scales become lighter colored; the fringe of the hind wing is longest and blackish at the nervule tips, elsewhere dull white, overlaid on the basal two-fifths with dark brown scales, sometimes tinged in part, especially in the female, with ferruginous; inner edge of hind wings with intermingled slate brown and pale hairs. Discal spot on the fore wings of male very small and very inconspicuous, nearly obovate, the ends not quite fully rounded, 1.5 mm. long, twice as long as broad, dark grayish brown. Costal margin of hind wings straight, the outer angle broadly rounded, the outer margin regularly rounded, the rounded projection of the lower median nervule scarcely larger than that of the middle nervule, both distinct.

Beneath: *fore wings* yellowish brown, fuliginous beneath the median nervure; two transverse bars of dark cinnamon brown cross the cell, the inner slightly bordered interiorly with black, the outer edged with a few white scales; an irregular, broken, dark cinnamon brown band, edged externally by a slender line of black scales, bordered conspicuously with white, crosses the wing, with a general direction subparallel to the outer border, at less than half the distance from the middle to the outer edge of the wing; from the costal border to the median nervure it is irregular in direction and has a slightly inward course, striking the latter just beyond the middle of the upper branch; in the median interspaces it consists of two lunules opening inward, the interior border of the upper arising beyond the exterior border of the upper portion of the band, the exterior border of the lower generally starting from the interior border of the upper; when the band crosses the medio-submedian interspace, which it seldom does, its upper extremity is distant from the lower end of the lunule above by the width of the interspace at this point; a submarginal row of small black sagittate spots, one in each interspace, is situated in a slender stripe of cinnamon scales, between which and the cinnamon line forming the border, the space is filled with pearly roseate scales, interrupted, beyond the middle, by an inconspicuous, irregular, cinnamon line, outside of which the scales are more pearly than roseate, and inside of which more roseate than pearly; some of the scales in the upper half of the wing, between the sagittate spots and the median band, and even sometimes as far as the inner discal bar, are tinged with roseate; these markings vary a good deal and are frequently blurred by a general suffusion of colors; fringe like the upper surface, with the white more conspicuous. *Hind wings* with an exceedingly broad, dark cinnamon brown band, generally much darker toward the edges, crossing the wing before the middle; exteriorly it is narrowly bordered, on all the transverse portions of the boundary, with black, surmounted by white; the interior border crosses the wing irregularly, anterior to the first divarication of the median nervure, and is broken at the subcostal nervure; the exterior border crosses the wing in an exceedingly irregular course: starting at the costal border but a short distance beyond the first divarication of the subcostal nervure, it crosses the next interspace, between the subcostal nervules, midway between the divarication and the outer border; in crossing the two succeeding interspaces it turns inward again, until it reaches the median nervure; here it again turns suddenly outward and crosses the two median interspaces in a straight line at right angles to them, and reaches the lower nervule at a point midway between its origin and termination; here the band suddenly diminishes one-half in width and the border crosses the remaining two interspaces in two undulations, the latter extending furthest outward. Within the band the vein closing the cell is bordered on either side by a line of black scales, sometimes confluent, inconspicuous when the band is uniformly dark; inwardly the base of the wing is filled with a mixture of black, brown, dark orange, white and roseate pearly scales, forming irregular, dark and roseate patches; outwardly the band is bordered by another much narrower but considerable band of dark fulvous and pale roseate scales, the latter predominating, giving it a gray appearance; its outer limit is marked by an extremely zigzag, sometimes slender, sometimes conspicuous line of black scales, most conspicuous and extending nearest the border in the median interspaces, in each of which it forms a Λ .

Beyond this the wing is dark cinnamon brown, obscured by pretty large, triangular patches of loosely crowded, white, iridescent scales*, one patch between each interspace, increasing in size toward the outer angle of the wing, the scales most loosely crowded at the base of the triangles, which are seated on the cinnamon line forming the border; above each of these triangles, but slightly separated from them, is situated a row of delicate flushes of pale roseate scales, occasionally obsolete; cinnamon border interrupted with black on either side of the nervure tips; wing covered also with long, scattered, exceedingly delicate hairs, white or fulvous, according to the color of their point of origin; fringe much as on the upper surface, but more variegated and brighter.

Abdomen covered with mingled slate brown and gray brown scales, beneath with a few short silvery gray hairs. Upper edge of alations of male upper organ (34:21) a little more roundly produced next the bottom of the notch than in *I. augustus*; so too the outer posterior lobe is slightly larger and less pointed; clasp tapering very regularly throughout.

Measurements in millimetres. Length of tongue, 5.75 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	11.5	13.	14.	12.5	14.	14.5
antennae.....	6.25	7.	8.25	6.25	6.25	7.
hind tibiae and tarsi..	3.5	4.	4.5	4.	4.5	4.5
fore tibiae and tarsi..	2.5	2.75	3.	2.75	3.	3.

Secondary sexual peculiarities. For the male stigma, see the description of the fore wings. The scales from the stigma (46:26) are stouter than in the other species of the genus, being but little more than three times as long as broad with slight basal lobes, a well rounded apex and scarcely convex sides, equal in the middle third.

Egg (65:7). Completely studded with blunt conical tubercles .017-.025 mm. high and of about the same diameter at their base, connected by coarse ridges of nearly equal elevation and averaging .0075 mm. broad, so as to form in the interspaces rude triangular pits, whose longer diameter is .038 mm. and the shorter .025 mm.; the width of the rude hexagon of which each prominence is the centre is about .08 mm. in diameter; the surface of the tubercle is crowded with transverse wrinkles; the surface of the pits has the peculiar appearance of frosted glass. Micropyle rosette (68:7) .13 mm. in diameter, sculptured with minute raised lines dividing the floor into broadly ovoid cells, the longer diameter of which is about .017 mm.; the central cell, which is .0085 mm. in diameter, is surrounded by only three or four of the oval cells, the longer (instead of, as elsewhere, the shorter) diameters of which are directed toward the centre. Color not very pale green, the reticulation white. Height, .38 mm.; breadth, .78 mm.

This egg differs from that of *I. iris* not only in size but also in the much lesser regularity of the markings, in the rugosity of the surface of the cells, in having the walls of the cells low, broad, heavy and wrinkled, instead of high, abrupt, comparatively slender and nearly smooth.

Caterpillar. First stage. Head yellowish brown; ocelli pale in a black field. Body pale greenish, marked with yellowish brown, especially in curving patches on the sides and a lunate spot on the dorsum of each segment; bristles colorless; spiracles blackish; warts pellucid. Length of dorsal hairs, .35 mm.; breadth of dorsal hairs, .01 mm.; length of short lateral hairs, .064 mm.; breadth of space between laterodorsal row of hairs, .1 mm.; length of long lateral hairs, .15 mm.; length of dorsal warts, .042 mm.; length of body, 1.85 mm.; height, .24 mm.; breadth, .32 mm.; breadth of head, .32 mm.

Last stage (75:24). Head yellowish. Body pure transparent green, with four longitudinal white stripes and on the first thoracic segment a transverse lozenge shaped white patch. Segments somewhat elevated in the middle of their diameter

*In one instance I have found them luteo-ochraceous.

and thinly covered with yellowish brown short hairs. Length, 11.5 mm. (Sanborn.)

Head pale brownish white, shining. Body above green, but with a tinge of yellow; dorsal area bordered by a bright whitish yellow line, sides becoming paler below; substigmatal fold marked by a bright whitish yellow line; first thoracic segment paler than the rest of the body, somewhat polished and without markings; under surface slightly paler; legs whitish, shining and semitransparent; prolegs green, tipped with whitish. Length, 16 mm. (After Saunders.)

Chrysalis (84:38,40). Nearly uniform blackish brown throughout, tinged with very dark, inconspicuous, yellowish brown in a broad dorsal patch on the mesothorax and to a greater or less extent, but irregularly, on the dorsal region of the abdomen, on the whole prothorax and the basal wing tubercle. More or less blotched with the same over the whole under surface; a slender raised dorsal line on the anterior half of the mesothorax; the raised lines are blackish, the hairs blackish or reddish; spiracles dark luteous. Length, 9.75 mm.; breadth at thorax, 4 mm.; at abdomen, 5 mm.; height at thorax, 4 mm.; at abdomen, 4.35 mm.; length of hairs, .24-.30 mm.

Distribution (23:3). This butterfly is a member of the Alleghanian fauna and is perhaps most abundant in its northern half; it is given by Abbot among the insects of Georgia as "very rare," and probably occurs only in the neighborhood of the mountains; with this exception the southernmost locality from which it is reported is Philadelphia (Grote, Blake). It seems to have been seldom taken west of New York, but Edwards accredits it to the "Middle States" and Reakirt quotes it among the butterflies of the Rocky Mountains of Colorado as differing in no respects from eastern types. Indeed it is not impossible that the California eryphon described by Boisduval may prove to be this species, which it certainly closely resembles. Edwards credits it to the western states without specification and in my Buffalo list I added Texas, but I cannot now recall on what authority. To the north it has been taken at Albany and Bethlehem, N. Y. (Lintner), London, Ont. "not common" (Saunders), Sorel (D'Urban), Montreal very rare (Coulfield), Ottawa abundant (Fletcher), and Halifax, N. S. "not uncommon" (Jones).

In New England it has been found in widely separated localities,—more abundantly at the south than at the north. It has been taken in Norway (Smith), Orono (Fernald), Hallowell (Miss Wadsworth) and Brunswick, Me. (Packard), Milford common (Whitney) and the White Mountains, N. H. (Sanborn), where I have taken it on the very summit of Mt. Madison, 5381', Andover (Sanborn, Scudder), the vicinity of Boston (Harris, Merrill, Faxon, Clapp, Maynard, Scudder), Walpole (Guild), Springfield (Emery, Dimmock), Amherst (Parker), Middleboro (Hamblly) and Cape Cod, Mass. (Fish); and Farmington, Conn. (Norton).

Food plants. The caterpillar feeds on pine, probably on several species. Abbott specifies "short-leaved pine," which Dr. Chapman supposes to be *Pinus mitis* Michx., though *P. inops* Ait. is mentioned on one MS. (a species Dr. Chapman thinks is not found in Georgia) and *P. taeda* Linn. on another. Mr. Sanborn has taken it on white pine (*Pinus strobus* Linn.). Mr. Saunders does not specify the species of

pine on which he found the larva. Messrs. Faxon and Merrill have always found the butterfly near red cedars (*Juniperus*) and conjecture that the larva may live upon them; while Mr. Emery has always found the butterfly upon *Lupinus perennis* Linn., among the scrub-pines of the plains in the neighborhood of Springfield, Mass., scarcely ever upon the pines themselves. Nor is this at all an improbable food plant; for in September, 1872, Mr. E. P. Mann received from Mr. N. C. Peabody, who collected it in Concord, Mass., a larva of this species feeding in a fresh garden bean pod; "when received, the larva had eaten into the pod, and had eaten a bean within, and it ate more afterward." It changed to pupa in September, and the species has been determined by me from the chrysalis, which never hatched.

Life history. The butterfly "comes abroad in April, and the fore part of May," writes Fitch; it does not, however, appear until the very last of April, sometimes not until May; it becomes abundant at the end of the first week of May and continues to fly throughout the month, but is seldom seen at all in June; apparently the females appear as soon as the males, and according to Messrs. Lintner and Meske are, in general, more abundant than they. The eggs, which hatch certainly within a fortnight and probably much sooner (ten days, Fletcher) are laid in the latter half of May; the larvae attain maturity toward the end of June and the first half of July; but plainly this maturing may be greatly delayed, as in the case related of the bean-pod larva. The chrysalis remains unchanged until spring. In the south, according to Abbot, the butterflies make their appearance the last of March from wintering chrysalids which have lasted since early in June of the preceding year.

Habits, flight, etc. The butterfly may be found upon the flowers of *Gnaphalium* (Harris) and often on or near red cedars (Faxon, Minot). Mr. Emery finds it frequently upon the flowers of lupine (*Lupinus perennis*); Mr. Abbott says that in the south it frequents oak woods and the borders of swamps. It may often be discovered by jarring the trunks of pine trees, upon which the female alights to lay eggs.

Mr. Fletcher found it flying about the tops of pines thirty feet from the ground; but on a subsequent day when they were battered, but still before he obtained his eggs, they were found in greater abundance in a field bordering the pine grove, where a great deal of the herbage was made up of *Antennaria plantaginifolia* in flower. Maynard speaks of the butterflies as frequenting sheltered woodlands, and says he has found them "feeding on the sweet scented flowers of the locust, but early in spring they are fond of resting in the bright sunlight in the woods."

The flight of this butterfly resembles that of *I. augustus* but is slower when undisturbed. At other times, as when it meets its mates, it is very "quick and jerky" as Fletcher describes it. It does not persistently keep so

near the ground, but often flies to a considerable height. Mr. Faxon remarks that small companies may be seen from six to twelve feet above the ground sporting about cedar trees, and adds that they very much prefer to remain about the same tree. Their habits of moving the hind wings has been observed by many; Fletcher says "when visiting the flowers of *Antennaria* for honey, it has a curious habit of slowly moving its lower wings, while closed, alternately up and down"; this gives it an appearance of satisfaction at its repast.

When at complete rest, the wings are held erect, the front edge of the hind wing reaching the upper median nervule of the fore pair; the body is parallel with the surface of rest, and the antennae, as seen from the side, arcuate to the base of the club, the latter straight and parallel to the body; as seen from the side they are perfectly straight throughout and spread at right angles.

Desiderata. The intermediate stages of the caterpillar should be described and its behavior, the food plant being very different from that of other species of the genus. Does it ever feed on the other plants suggested as its food,—*Juniperus*, *Lupinus*? and what sort of a place does the caterpillar seek for change to chrysalis? We have much to learn about the distribution of this butterfly, and no parasites are known.

LIST OF ILLUSTRATIONS.—*INCISALIA NIPHON*.

<i>General.</i>		<i>Imago.</i>	
Pl. 23, fig. 3.	Distribution in North America.	Pl. 6, fig. 21.	Female, upper surface.
<i>Egg.</i>		23.	Male, both surfaces.
Pl. 65, fig. 7.	Plain.	13: 1.	Plain, both surfaces.
68: 7.	Microphyte.	34: 21.	Male abdominal appendages.
<i>Caterpillar.</i>		39: 13.	Neuration.
Pl. 75, fig. 24.	Full grown caterpillar.	46: 26.	Androconium.
<i>Chrysalis.</i>			
Pl. 84, fig. 38, 40.	Side views.		

INCISALIA IRUS.—The hoary elfin.

[Black brown hair streak butterfly, swamp brown hair streak butterfly (Abbot); hoary elfin (Scudder); pearly streaked butterfly (Maynard).]

Polyommatus irus God., *Encycl. méth.*, ix: 610, 674 (1819).

Thecla irus Boisd.-LeC., *Lép. Amér.* sept., 101-102, pl. 31, figs. 5, 6 (1833);—Morr., *Syn. Lep. N. Amer.*, 97 [iris] (1862);—French, *Butt. east. U. S.*, 273 (1886);—Mayn., *Butt. N. E.*, 37, pl. 5, figs. 46, 46a (1886).

Incisalia irus Scudd., *Syst. rev. Amer. butt.*, 32 (1872).

Thecla irus var. *arsace* Edw., *Cat. Lep. Amer.*, 41 (1877);—Fern., *Butt. Me.*, (1884).

Thecla irus var. *mossii* H. Edw., *Pap.*, 1: 54 (1881).

Thecla arsace Boisd.-LeC., *Lép. Amér.* sept., 103-104, pl. 32, figs. 1-5 (1833);—Morr., *Syn. Lep. N. Amer.*, 97-98 (1862).

Thecla henrici Grote-Rob., *Trans. Amer. ent. soc.*, 1: 174-175 (1867);—Scudd., *Proc.*

Bost. soc. nat. hist., xl: 378 (1868);—Edw., Pap., i: 150-152 (1881);—Fern., Butt. Me., 82-84 (1884);—French, Butt. east. U. S., 273-275 (1886).

Figured by Abbot, Draw. ins. Ga., Oemler coll., Bost. soc. nat. hist. 18, 19;—Glover, Ill. N. A. Lep., pl. B, figs. 10, 11; pl. E, figs. 18-20; pl. H, fig. 8, ined.

"So Spring returns, and, with her, Love,
Whom small sweet larks in heaven above,
Coy butterfly, coo-cooing dove,
Fond youth and maid;
Ay, all glad hearts are telling of,
But mine," he said.

GRAVES.—*The Gifts of Glendore.*

Pretty flower that June remembers
Blossom that July forgets.

A. R. GROTE.

Imago (6: 19, 22). Head covered above and behind with long, overarchling, coarse, brazen tawny hairs, with a few scattered white ones; in front with black scales, interspersed sparsely with dark brownish red hairs; a rather broad band of snow white scales encircles the eye and basal antennal joint, excepting the back of the antennae; it is slender in front of and above the antennae, and the two are nearly connected by a similar band just above the tongue. Basal joint of antennae naked, blackish; stalk and base of club black, conspicuously annulated with white at the base of each joint, more broadly beneath than above, extending in a confluent, angulated streak over the whole under surface of the base of the club, and sometimes prolonged delicately to the colored tip; rest of club dark velvety brown, the terminal two or three joints luteous. Basal and middle joints of palpi gray, with intermingled black and white scales, greatly elongated into a tuft, frequently with an infusion of long, luteo-ferruginous scales, the black scales the longer; above, and also the terminal joint black, with but few intermingled white scales; extreme tip white.

Thorax covered above with exceedingly long, fine, tow-colored hairs, sometimes tinged with a very pale greenish blue, the patagla with very pale brown, dull hoary and a few scattered dull ferruginous scales; beneath, covered profusely with moderately long, hoary hairs, with some interrupted, short, brownish ones. Legs blackish or dark brown, the femora almost entirely concealed by a profusion of snow white scales and tufts of rather long, white, and testaceous hairs on the under border, the tibiae with a similar covering of white scales, especially on the inner side, but less frequent, the outer side having generally one or more distinct dark patches; tibiae above with a slender annulation of white scales at the tip of each joint and a few scattered scales in the middle of the upper surface of the basal joint; beneath yellowish brown; spines black; claws dark reddish yellow.

Wings uniform dark, glossy, slate brown, with a very faint olivaceous reflection; either occasionally the base of the costal border of the fore wings, more or less of the anal angle, and sometimes the tip of the lower median nervule of the hind wings tinged delicately and faintly with ferruginous (♂); or, occasionally, the base of the costal border of the fore wings, and more or less of the centre of the outer half of both wings (on the hind wings especially toward the anal area) tinged distinctly but rather delicately with tawny ferruginous, the veins blackish (♀); fringe dark brown, with a central whitish line, most conspicuous near anal angle of hind wings, the darker parts sometimes interrupted with whitish at the interspaces, and especially on the upper half of fore wings; internal border of hind wings with a fringe of pale brown hairs, tawny at the anal angle; discal spot of fore wings of male very long (1.75-3 mm.), three or four times as long as broad, subfusiform, rounded at either end, blackish brown. The upper half of the cross vein connecting the first and second inferior subcostal nervules of the fore wings is bent strongly inward in passing upward, partaking to a certain extent the downward curve of the veins at this point, seen in the male. Costal margin of hind wings slightly concave, its outer angle abrupt, scarcely rounded, the outer border slightly and roundly angulated in the middle, even

In the male, the projection of the middle median nervule exceedingly slight, that of the lower median nervule distinct.

Beneath; *fore wings* lighter or darker grayish tawny brown, made up of a mixture of tawny, very pale greenish and dark violaceous brown scales, the last predominating next the base, the first upon the apical half, the pale scales mainly scattered among the tawny ones; below the median nervule it is duller colored; there is sometimes a faint dusky bar at the extremity of the discoidal cell; about two-fifths the distance from this bar to the outer border, subparallel to the latter, and extending over the brighter part of the wing is a narrow, transverse, irregular, white and black stripe (the inner side black, the outer white), which is sometimes continuous, but below the upper median nervule is usually broken into short streaks, each crossing an interspace, and placed alternately a little within and a little without the general direction of the stripe; there is a narrow marginal, deeper cinnamon tawny band, occasionally made hoary by abundant pearly scales, often enclosing small, darker spots or longitudinal streaks in the interspaces, followed by a slender, indistinct line of paler scales, and again by a band similar to the marginal band, but narrower, not so dark, and surmounted in each interspace by a small, often obsolete and usually indistinct, blackish, sagittate spot; fringe white, interrupted broadly at the nervule tips with black, edged at the extreme base with bluish black scales. *Hind wings* with a very broad, nearly uniform, very dark reddish brown band in the basal half of the wing, composed of very dark purplish brown, ferruginous and violaceous, or pearly, or even occasionally bright green scales, the first predominating; the interior edge of the band is always inconspicuous and frequently obliterated; when present, it is indicated by the slightly paler base and occasionally by a line of darker scales, sometimes partially lined with whitish; it starts from the inner border, midway between the exterior edge of the band and the base of the wing, and extends in a line parallel to the border as far as the median nervule, where it bends at right angles, and terminates on the costal margin; the exterior limit of the band is more irregular, but preserves the same general direction; it is marked by a narrow edging of white scales, which is sometimes wholly or partially obsolete, especially in the middle portion, and sometimes is preceded inconspicuously by a slender line of black scales; it starts from the costal border at about three-fifths the distance from the base of the wing, crosses the first interspace at right angles to the border, and is almost always bordered more conspicuously with white at this point where it is broken and crosses the upper subcostal interspace in the same direction, but farther removed from the base of the wing by about the width of an interspace at this point; the succeeding interspace is crossed in continuation of the primary course of the band and the line is then usually bent at an angle, with a straight course, but sometimes curved or even bent toward the tip of the lowest median nervule, where it reaches its greatest outward extension in crossing at right angles the upper median interspace at about three-fifths the distance from the base of the wing; from here it passes toward the inner border over the two succeeding interspaces, usually in a series of descending steps; and then by a slight outward curve reaches the inner border a little before the tip of the abdomen. Beyond this is a paler band, as broad as the interspaces, made up of a mixture of pale slate and tawny scales, the portion on the lower half of the wing usually more or less brightened by an admixture of white scales; the outer border of this band, especially on the upper half of the wing, is ill-defined, but when most distinct consists of a row of blackish or dark reddish brown zigzags in each interspace, sometimes reduced to a series of spots or dots, subparallel to the outer margin of the wing; that in the interspace next the inner margin consists of an oblique dash edging the upper portion of the angular excision on the inner margin of the wing and is met by a similar one edging the lower portion of the same, and which is limited exteriorly above by a few long white scales. Beyond this band the wing is dark reddish brown, made up of dark tawny scales, frequently with a few intermingled green ones, and obscured and rendered hoary by cloudy, scattered pearly scales, which are almost confined to the lower two-thirds of the wing, but are usually absent from a small spot

in the lower submedian interspace, and partially so in a series of obscure marginal spots; frequently the hoary markings of the posterior half of the wing are limited by a nearly straight line, formed by the lower half of the outer margin of the broad band and its continuation; outer edge marked by a line of dark reddish brown scales; basal half of the fringe reddish brown, apical half dull white, interrupted at the nervures with blackish brown.

Abdomen covered above with purplish black and rich deep brown scales, on the sides with the same, but with frequently interspersed pale brown and whitish scales; beneath grayish white, brownish toward tip; outer edge of alations of upper organ of male (♂: 22) almost straight, the inferior lobe inconspicuous, broadly rounded; clasp slenderer than in the other species, and tapering regularly.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	11.5	13.	13.25	13.5	13.75	15.
antennae.....	6.	6.35	6.75	6.5	6.65	7.25
hind tibiae and tarsi.....		4.			4.	
fore tibiae and tarsi.....		3.			4.	

Variations. One specimen from Norway, Mc. (No. 1527, Mus. Yale Coll., S. I. Smith) differs from the norm in wanting the excessive prolongation of the scales at the tip of the nervures of the hind wings, and in having the male discal spot of the fore wings small and scarcely more than twice as long as broad; the outer margin of the fore wings is also narrowly hoary, similar in color to the border of the hind wings. This same combination of characters is also found in a male from Needham, Mass. (taken as early as April 28), which Mr. Whitney has shown me. Two females, one from an unknown locality, taken May 12 (Whitney), and the other taken in Walpole, Mass. (Miss Guild), have equally entire wings and hoary edged fore wings, and the former has also the upper surface of the wings distinctly tinged with olivaceous. Although these characters seem to be thus correlated, they cannot be deemed of more than incidental value, for a male from Middleboro, Mass. (Hambly), which possesses the short sexual dash, has at the same time hind wings which are distinctly tailed and fore wings without hoary scales: so too a specimen from Albany, N. Y. (Lintner) has the principal tail of the hind wings only half as broad and twice as long as usual.

A female from Albany sent me by Mr. Lintner differs from ordinary specimens simply in a greater straightness of the extra-mesal stripe on under surface of the fore wings, and in the tint of the color beyond the stripe on both wings; it has a decidedly olivaceous hue; but another specimen from same locality stands in both these respects midway between this form and the typical *irus*. They illustrate an extreme of coloration in a special direction, curiously accompanied by a more than usual straightness of the extra-mesal line of the fore wing beneath. In every other particular it is perfectly matched by other specimens.

Buffused variety. *INCIS. IRUS BALLEATA.* A suffused specimen taken in Centre, near Albany in May 1876 by W. W. Hill, was sent me by Mr. J. A. Lintner. It is a female; above there is nothing peculiar about it excepting that the color is unusually dark (like other specimens I have seen from Centre); beneath the lilaceous powdering of the margin of the wing is wanting, as if to give intensity to the suffusion of the other parts, which is brought about in this way: the row of roundish dark spots, normally situated on the fore wing, half way from the irregular extra-mesal band to the border, and on the hind wing, one-quarter way from the corresponding mesal band to the border, is present, the spots a little diffused; the darkest portion of the irregular band is also present as a series of similar spots and between them the whole space is occupied by a powdering of lilaceous or hoary scales, being the diffusion of the white portion of said band broken more or less distinctly into spots by the dusky nervures; on the hind wings the inner band is lost, as it frequently is in otherwise unsuffused specimens, in cloudy hoary patches over the base; while midway between the suffused hoary belt just described and the margin of the wing is another broader, cloudy belt of hoary

or lilaceous scales more sparsely scattered than in the suffused belt and enlivened in the lower median interspace by the normal dark spot of this place which falls in its middle. The wings extend 30 mm.

Secondary sexual peculiarities. The discal stigma of the male is described under the fore wing. The scales which occur there (46:25) are pretty large, quadrangular, about four times as long as broad, the apex truncate with rounded angles, the base faintly lobed.

Egg (65:9, 10). Shell very thin, shining and smooth, ornamented with very high ridges, arranged with some regularity; where they cross each other thickened, forming stellate, six-rayed prominences; the lines connecting the extremities of the rays form regular hexagons, .11 mm. in breadth; the thickened centres are .03 mm. in diameter and at least .02 mm. high; the connecting lines are delicate, straight and less elevated than the centres; the cells are arranged in rows, one of which is nearly horizontal, and the others divide it at opposite angles; above, the ridges diminish in height and regularity, leaving, next the centre of the summit (68:8) a space comparatively smooth. Micropyle rosette .19 mm. in diameter, the cells nearly circular, but angular and averaging .0234 mm. in diameter; the central one circular, .017 mm. in diameter, and surrounded by six circular cells of nearly the same size. Color very deep green, the elevations pale green. Height, .3 mm.; breadth, .62 mm.

Caterpillar. *First stage.* Head (79:42) pale yellowish, ocellar field large, round, black. Body very pale greenish yellow, the dorsal hairs provided with excessively minute spicules, which on the same side are a little further apart than the width of the hairs; spiracles brownish with a whitish annulus in the middle; hairs colorless, dusky at the very base, the short bristles of the laterodorsal row dusky, tipped with black. Length, 1.25 mm.; breadth of head, .25 mm.; length of dorsal hairs, .3 mm.; basal breadth of same, .006 mm.

Second stage. Head yellow green. Body dull yellow green on dorsal area with a dorsal red brown stripe reaching to the eighth abdominal segment; sides red brown, limited above by a macular brown line at the outer edge of the dorsal area, and with an infralateral (?) yellowish line; substigmatal fold yellowish; under surface yellow green; upper surface with many short, stiff, brown hairs. Length, 2 mm. (After Edwards.)

Third stage. Body red brown and dull yellow green; a red dorsal band, tapering to a point behind, with a mediodorsal green line; rest of dorsal area green, but including a little red brown space on each segment; sides red brown, with a green infralateral (?) line; substigmatal fold green. Length, 3 mm. (After Edwards.)

Last stage (75:22, 23, 24). Pe ♂ yellow green. Body with the dorsal area yellow green, the lateral red brown with an infralateral (?) indistinct green line; substigmatal fold green. Body covered with short, brown hairs. Subsequently, shortly before pupation, the general color changes to port wine-red, but with the laterodorsal ridges yellow green, tinted posteriorly with red on each segment; a pale red line along substigmatal fold. Length, .13 mm. (After Edwards.)

Another specimen, confidently presumed to belong to this species, was "yellow green, yellow predominating on the sides; the dorsal elevations have the summits yellow, the outsides greenish; the mediodorsal stripe green, edged on either side by a brown line" (Edwards).

Chrysalis (84:26, 32-34). "Black or brown black with obscure red bands; there being on either side a narrow black stripe in the middle of the abdomen; a mesonotum this stripe disappears and the red remains" (Edwards).

Distribution (23:4). This butterfly is also a member of the Alleghenian fauna, but unlike the other species of *Incisalia* it is more abundant southwardly, not occurring at all in eastern Canada and extending to the Ogeechee Swamp in Georgia (Abbot) where, however, it is "far from

common." Mr. Atkinson also brought it from South Carolina. The northernmost locality outside of New England in which it has been taken is Albany, N. Y. (Lintner, Peek), where it is extremely abundant, and Racine, Wis. (Hoy), where it is rare; it does not seem to have been found abundantly inland, occurring mainly in the Coast states, but, besides the Wisconsin locality, it is reported from Illinois (Worthington) and eastern Kansas rare (Snow). But besides this, a variety, *mossii*, has been found on Vancouver Island, which perhaps is the form reported by Rev. Mr. Holland as found at Canmore on the Canadian Pacific R. R. west of Calgary. These localities are very far removed from its presumed home.

In New England, it is a rare insect, except in the most southerly portions. It has been taken, however, as far north as Norway, Me. (Smith) and is reported by Messrs. Grote and Robinson from the same state, as well as by Professor Fernald who found it common at Orono. In New Hampshire it has been found at Milford "scarce" (Whitney); in Massachusetts at Springfield (Emery), Needham (Whitney), Walpole (Guild), Middleboro, not infrequent (Humbly), at Turkey Hill and Malden (F. H. Sprague), and on Nantucket (Scudder); in Rhode Island Mr. Hambly found it at Portsmouth and in Connecticut it is reported from Norwich (Scudder) and New Haven (Smith — Mus. Yale Coll.).

Oviposition. Edwards tells us that the egg "is laid at the base of a flower stem of wild plum." Fifteen were obtained by him from an enclosed female, and they were laid in a bunch, all but one at the base on the upper side. Probably in nature they would have been scattered on different flower stalks and not clustered. They are evidently laid, Edwards remarks, "just at the right season for the caterpillars to seize the newly found plums. A little too early or a little too late might be fatal," the plums in this instance being "but just from the blossom and tender enough for so minute a caterpillar."

Food of caterpillar. Abbot states that the caterpillar feeds on the "swamp huckleberry"—probably, says Dr. Chapman, *Vaccinium corymbosum* Linn. Abbot also gives as its food plants *Leucothoe racemosa*, *Cyrilla racemifolia* and holly. I imprisoned six ripe females on a budding *Leucothoe racemosa* for two weeks with no result and yet in two instances I have known eggs to be laid by females shut up in chip boxes. Mr. Lintner once raised eight or ten butterflies from the larva, taken he thinks on *Lupinus perennis*, but with the loss of his notes about them he is not confident. Edwards tried enclosing females on *Vaccinium* and *Quercus* with no result, but at last met with complete success with wild plum, this being suggested to him by his once finding an unknown lycaenid larva on a plum he had plucked. The caterpillars were fed to maturity on wild plums, which they preferred to damsons. It is interesting in this connection to notice that Abbot states that the species "frequents the blossoms

of the Judas tree (*Cercis canadensis*) and wild plums on the edge of swamps."

Habits of the caterpillar. On this point we have only the observations of Edwards. On leaving the egg scarcely more of the shell is eaten than enough to permit egress. "The young larva at once makes its way up the stalk and fastens on the young plum, boring into it" just as *Cyaniris* bores into a bud. Edwards found that "a hole was eaten out large enough for the head to enter, and thereafter the caterpillar spent most of its time with head in the cavity." The drawings (75:22, 23) which I owe to the kindness of Mr. Edwards show this well.

When a moult approached it came out of its burrow and rested either on the side of the plum or on the leaf. . . . When half grown it seemed to have its head and shoulders buried at least from 6 A. M. one day to 9 P. M. the next, with no withdrawal observed by me, and I looked at it frequently. Cutting open the plum the excavation would be found reaching quite across and around the pulpy stone, which in the earlier larval stages was not eaten. But after third moult this was eaten and the entire plum excavated. In no case was the skin eaten except at the entrance.

Life history. The earliest males of this butterfly appear in New England about the 24th or 25th of April and thereafter become abundant in a week, the females apparently make their advent during the first week in May; but fresh specimens may even occasionally be obtained toward the middle of June. Usually, however, after the 20th of May only rubbed specimens, in diminished numbers, will be found. They continue upon the wing until after the middle of June; the eggs are laid in the latter half of May and in June, but all the instances known to me in the north are of those laid after the first week in June; they hatch in less than a week—how much less is unknown, nor have we any statistics concerning the time of pupation, which undoubtedly continues over the winter. Mr. Edwards, however, obtained eggs laid in the middle of May in West Virginia, which hatched in five days, the caterpillar changed to chrysalis in three weeks and this hibernated. Strange to say, this butterfly, according to Abbot's notes and as may be judged from Edwards's brief statements, does not make its appearance in Georgia any earlier than with us. Abbot captured specimens April 20 and bred one from the chrysalis May 6th; while according to his notes, *I. niphon*, which with us is nearly synchronous in its apparition with this species, appears in Georgia a month earlier. So, too, from Vancouver Island I have seen specimens of the present species taken April 25.

The observations of Mr. Lintner on this species for 1869 seem to me to represent the coming and going of this species so well that they may be taken as a fair average statement for a place where the butterfly is common. After mentioning that one male was taken on April 27, he goes on to say:—

On the 11th of May, at the next visit made, both sexes were found abundantly, most

of them somewhat worn. Sixty individuals were taken in about three hour's collecting. Previous to 11 o'clock, much the larger proportion of captures consisted of females; subsequent to that hour, the males were the more numerous. On the 25th they were still abundant. June 7th and 9th, a few much worn were seen; on the 15th it was observed for the last time for the season, it being single brooded.

Habits, flight and postures. According to Abbot the butterfly frequents the blossoms of the red bud (*Cercis canadensis* Linn.) in old fields on the borders of swamps. Mr. Hambly noticed it in open spaces near low pine trees; but Mr. Lintner, who has found it so abundant near Albany, says it can be swept from its rest on the hot sandy road, though "the male was often taken while resting on bushes by the road side."

In flight it is ordinarily the least active of the Theclidi, for, though when alarmed or aroused by the presence of a companion of its own kind it can show as great activity as any, its ordinary movements, along the sandy roads it loves to frequent, are rather sluggish than brisk and nervous, and in keeping with this it hugs the ground or flies just on a level with the tops of the low whortleberries; and even when disturbed rarely rises above one's head.

When quiet, the wings are elevated and closely appressed; the wings are very apt to be a little inclined, the bent portion of the hind pair resting flat upon the ground. Like the other species of the genus, it rubs the hind wings together, but when completely at rest, all the portion of the fore wings below the lowest median nervule is concealed by the hind wings. The antennae are straight,—excepting the vertical bend at the base,—almost parallel with the body, but turned slightly downward and divergent at an angle of about 100°.

Desiderata. Our knowledge of the distribution of this insect, especially in the west and along our northern boundary, leaves much to be desired, especially in view of the captures at Canmore and Vancouver. Considering the length of time the female is upon the wing, we need to enquire especially during how extended a period the eggs are deposited; and the time when the larva matures is equally unascertained for the north. We need further notes upon the humors of the butterfly and the variation of the larva, as well as a full knowledge of its food plants; it is hardly probable that it is confined to plum, and the indications of Abbot and Lintner should be regarded. No parasites are known.

LIST OF ILLUSTRATIONS.—*INCISALIA IRUS*.

- | | |
|--|--------------------------------------|
| <i>General.</i> | <i>Chrysalis.</i> |
| Pl. 23, fig. 4. Distribution in North America. | Pl. 84, fig. 30. Side view enlarged. |
| <i>Egg.</i> | 32. Dorsal view. |
| Pl. 65, fig. 9. Colored. | 33, 34. Side views. |
| 10. Plain. | <i>Imago.</i> |
| 68: 8. Micropyle. | Pl. 6, fig. 19. Male, upper surface. |
| <i>Caterpillar.</i> | 22. Female, both surfaces. |
| Pl. 75, figs. 22, 23, 28. Full grown. | 24: 22. Male abdominal appendages. |
| 79: 42. Front view of head, first stage. | 46: 25. Androconium. |

INCISALIA AUGUSTUS.—The brown elfin.

[The brown elfin (Scudder); brown streaked butterfly (Maynard).]

Thecla augustus Kirby, Faun. bor. amer., iv: 298, pl. 3, figs. 4-5 (1837);—Morr., Syn. Lep. N. Amer. 103 (1862);—Harr., Ins. inj. veg., 3d ed., fig. 108 on p. 279 (1862);—Grote-Rob., Trans. Amer. ent. soc., i: 175-176 (1867);—Fern., Butt. Me., 81-82 (1884);—French, Butt. east. U. S., 272 (1886);—Mayn., Butt. N. E., 36, pl. 5, figs. 44, 44a (1886);—Fyles, Can. ent., xix: 147 (1887).

Thecla augustus var. *irioides* Scudd., Bull. Buff. soc. nat. sc., iii: 104 (1876).

Thecla augustus var. *crossoides* Scudd., Bull. Buff. soc. nat. sc., iii: 104 (1876).

Incisalia augustus Min., Scudd. Syst. rev. Amer. butt., 31-32 (1872);—Scudd., Geol. N. H., i: 356-357 (1874); Butt., 129-130, 308, fig. 123 (1881).

Thecla augustina Westw., Gen. diurn. Lep., ii: 486 (1852).

Thecla irioides Boisdu., Ann. Soc. ent. fr., (2) x: 288-290 (1852);—H. Edw., Pac. coast Lep., 130 [27: 2] (1878).

Figured by Glover, Ill. N. A. Lep., pl. 28, figs. 12, 13; pl. 38, fig. 8, ined.

These gay idlers, the butterflies,
Broke, to-day, from their winter shroud,
These soft airs, that winnow the skies,
Blow, just born, from the soft, white cloud.

BRYANT.—*The New and the Old.*

When daisies pied and violets blue
And lady-smocks all silver-white
And cuckoo-buds of yellow hue
Do paint the meadows with delight.

SHAKESPEARE.—*Love's Labour's Lost.*

Imago (6: 25; 13: 3). Front and summit of head covered with rufous hairs, those upon the summit slaty brown at base; eyes encircled, except at summit, by a slender row of white scales, intermixed with some slate brown scales, extending in front to the summit of the basal antennal joint and sometimes terminating behind in some rufous scales; these rows are not connected above the mouth by a similar band. Basal joint of antennae reddish brown, with a few white scales posteriorly; stalk of antennae blackish, with snow white annulations at the base of each joint, especially broad beneath, where they occupy nearly half of the joint; at the base of the club, beneath, the white scales coalesce and form a large patch, extending about one-third way up the club; club blackish or blackish brown, the apical and penultimate joints honey yellow and sometimes one or two of the following joints are partially discolored with the same. Basal and middle joints of palpi tufted with a grayish mixture of white, rufous and blackish brown elongated scales, the first predominating; terminal joint clothed with blackish brown scales, and excepting upon the upper surface, with a few scattered white scales, especially on the inside. Tongue pale testaceous at base, dusky beyond.

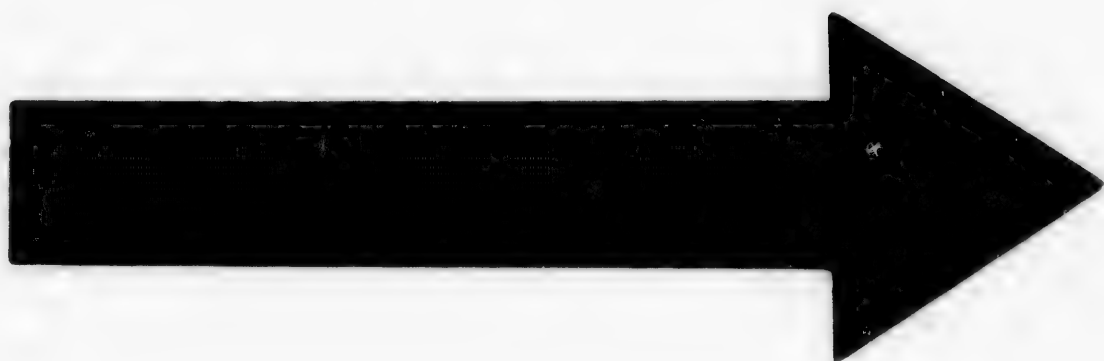
Thorax covered above with long, soft, delicate, dark mouse brown hairs; patagia with scales and hairs of similar color mingled with some of a pale tint; beneath, the thorax is covered with grayish hairs, intermingled at the sides with many rufous hairs. Femora covered on either side with pearly scales and beneath clothed with long gray and brown hairs, the latter most abundant on the hind pair; tibiae and tarsi covered with dark brown scales having a purplish reflection, the tibiae with a few intersprinkled white scales especially on the fore legs, on the inner side of which they predominate, and on the outer side of which they form two transverse lines crossing the leg at the middle and apex of the tibiae; the tarsi are also banded conspicuously with white at the apex of each joint; beneath they are yellowish brown; claws dark reddish.

Wings above dark soft slate brown, with very slight and delicate, dark, brassy green reflections, especially in sunshine, either occasionally (♂) or usually (♀) with a slight

tinge of dull ferruginous next the anal angle of the hind wings; the female also possesses a few bright ferruginous or orange scales just beyond the apex of the discoidal cell of the fore wings, and has the whole upper surface of the wings occasionally tinged in the very slightest possible degree with dull ferruginous; wings all edged delicately with black; hind pair frequently with a line of greenish pearly scales seated upon the outer margin, from the tip of the lower median nervule to the anal angle; basal half of the fringe blackish brown, apical half pearly white on the fore wings, interrupted at the nervure tips with blackish brown; on the hind wings similar, but with the white scales extensively supplanted by blackish ones. Discal dash on fore wings of male of medium size, 1.9 mm. long, obovate, broadly rounded at the tips, fully twice as long as broad, composed of blackish brown scales. Costal border of hind wings straight or slightly rounded, its outer angle very broadly rounded, the outer border rather regularly rounded (scarcely less so in the female), the projections of the median nervules very slight.

Beneath: base of the fore wings, as far as the transverse stripe, reddish tawny with a few dull slate brown scales scattered near the subcostal nervure; the parts covered by the hind wings dull slate colored; beyond the transverse stripe ochraceous, a few paler scales scattered upon the upper half. The transverse stripe crosses the wing subparallel to the outer border, at about two-thirds the distance from the base to the outer border and consists of a narrow band of blackish, or very dark reddish brown scales, sometimes bordered exteriorly, more or less distinctly, with white; it is irregular in direction and varies considerably in different individuals; usually it is nearly straight with an angular bend inward between the subcostal and median nervures; about midway between it and the outer border is a series of blackish interspaceal dots. Hind wings crossed in the middle by an irregular line of blackish scales, preserving a general course subparallel to the outer border, occasionally, and especially near the margins, bordered exteriorly with white; it starts on the costal margin at about three-fifths the distance from the base and crosses the first interspace in a straight line; next it follows the nervure outwardly for an equal distance and then crosses the next interspace at a right angle; from here it sweeps around by a deep inward curve to an equal distance outward at the upper median nervure and, having crossed two interspaces at right angles to the nervures, is bent considerably inward again and seeks the inner border, where, after sometimes suffering a slight outward bend, it terminates at about the tip of the abdomen; within this median line the wing is filled with blackish purple and bright cinnamon red, the former predominating next the median line and upon the outer lower half and frequently bordering the extremity of the cell, the whole speckled with scattered very pale purplish scales; outside of it, broadly toward the costal, narrowly toward the inner margin, the wing is ochraceous next the stripe, merging gradually into reddish tawny, with which the outer margin is broadly bordered, especially next the anal angle; the whole of this space is also sparsely flecked with very pale purplish scales, and contains, midway between the median line and the outer border (nearer the median line on the lower half) and mostly or entirely in the ochraceous space, a series of minute interspaceal blackish spots, which are frequently seated upon paler ochraceous spots and normally form sagittate cappings to them; in the middle of the excision of the inner border, at the very margin, are a few white scales and the marginal row of white scales seen on the upper surface next the anal angle is repeated beneath; the outer margin is delicately bordered by a broken line of blackish scales; fringe of both wings very similar to that of the upper surface, blackish purple at the anal angle; the excision of the inner margin of the hind wings is fringed with long white hairs. Occasionally the whole under surface of the wings is suffused with a purplish light.

Abdomen covered above and at sides with purplish brown scales, mingled with some pale slate brown scales next the thorax; beneath with grayish hoary scales. Edges of the notch of the upper organ of male (24:32) separated; the alations slightly sinuous; lower posterior angle of alations produced to a sharply pointed inconspicuous triangular lobe; basal half of upper edge of clasp a little rounded.



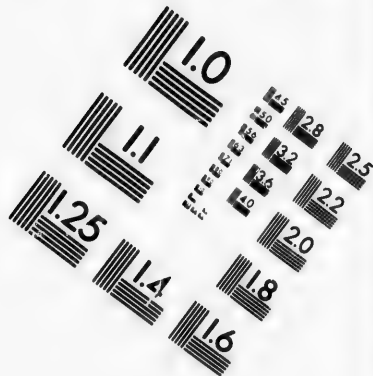
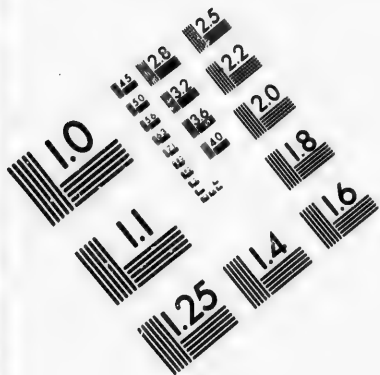
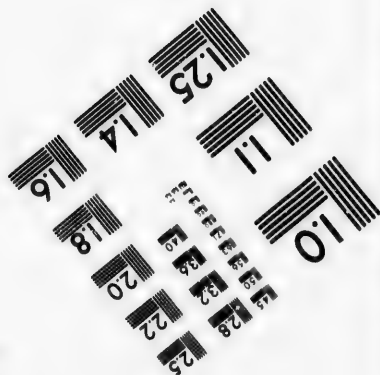
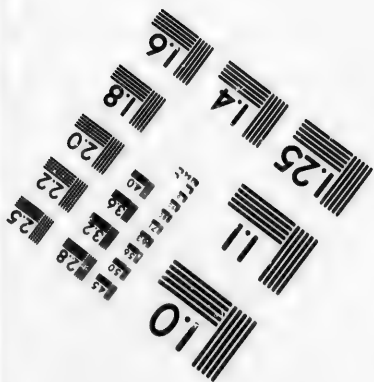
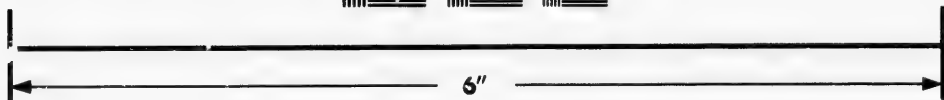
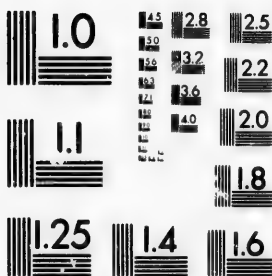


IMAGE EVALUATION TEST TARGET (MT-3)



**Photographic
Sciences
Corporation**

23 WEST MAIN STREET
WEBSTER, N.Y. 14580
(716) 872-4503

1.5 2.8 2.5
2.0 2.2
1.8

10

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 4.25 mm.						
Length of fore wings.....	11.75	12.	13.	11.75	12.5	13.
antennae.....	6.3	6.3	6.75	6.75	7.	7.25
hind tibiae and tarsi..		4.			4.	
fore tibiae and tarsi..		2.5			2.5	

Described from 29 ♂, 10 ♀.

Secondary sexual peculiarities. For the male stigma, see the description of the fore wings. The scales (46: 24) found in the stigma are much longer and slenderer than in the other species, being about six times longer than broad, nearly equal, with slightly rounded quadrangular ends.

Geographical variation. The form *I. a. irioides*, found on the Pacific Coast and looked on by many as a distinct species, differs but slightly though with apparently constancy from the eastern type. It is slightly the larger, never has the median stripe of the under surface of the hind wings bordered with white, and lacks generally the depth of tint upon the basal half of the under surface of the hind wings found in the eastern type; while the male has a slightly smaller discal stigma and the female nearly the whole upper surface of the wings distinctly suffused with dull ferruginous.

Caterpillar. Last stage. "Carmine red, covered with very short hair, each segment involute above, with deep double foveae" (H. Edwards). Length, 12.7 mm. (Nevada specimens).

Chrysalis. "Pitchy brown, covered with very short bristly hair; . . . wing-cases paler." Length, 10 mm. (H. Edwards). The chrysalis differs strikingly from *I. niphon* in the absence of piecous blotches covering nearly the whole ground. In place of these are a few small, circular, blackish fuscous spots sparsely scattered over the body, on the abdomen accompanied on each side by two rows of slightly larger and more distinct spots, an infralateral central row and a laterostigmatal post-central row, each with one spot to a segment. The tracery of raised lines is obscurely fuscous, more delicate than in *I. niphon*. The hairs are black and rather more sparsely distributed than in *I. niphon*, and the spiracles inconspicuous from being concolorous with the surroundings. (Nevada specimen.)

Distribution (23:5). The distribution of this insect seems to be somewhat peculiar, as our map makes clear. Apparently reaching its maximum of development in New England, it occurs also in the Canadian fauna even as far as Cumberland House on the Saskatchewan, nearly in the centre of the continent, and has been described from California as a distinct species of the Pacific coast; it has also been found in Arizona (Edwards), Utah (Palmer) and even in Colorado. Notwithstanding its occurrence in California and Colorado, it has not otherwise been reported in the United States west of New York (Albany, Lintner), but it follows the Appalachian chain to West Virginia. A specimen in the Yale College museum, No. 1762, is credited to the District of Columbia (Dodge). North of our boundary it occurs as far east as Halifax, N. S. "not uncommon" (Jones) and has been taken at Quebec (Bowles), Bergerville (Fyles), Montreal (Caulfield), and even at London, Ont. (Saunders); the western type occurs on the Saskatchewan as stated and at Vancouver Island (Fletcher).

In New England it is widely distributed and will probably be found in abundance over all the wilder portion. The northernmost point from

which it has been reported is Norway "very common" (Smith), and it is also found at Orono, Me. (Fernald). It has been taken in Milford, N. H. "rather common" (Whitney). In Massachusetts it has been found by many observers in several places near Boston, and is by no means rare; it has also been taken in Andover (Merrill, Alcott, Sanborn, Seudder), Mount Tom and other rocky hills near Springfield (Dimmock), Middleboro (Hamblly) and East Falmouth on Cape Cod (Fish); a single male was taken at New Haven, Conn. (Smith, Mus. Yale College), and I have found it abundant on Nantucket.

Food plant of caterpillar. The food plant is unknown. Mrs. Edwards found her specimens "crawling upon bare granite rocks, near patches of Sedum." I am satisfied that the caterpillar found by me on *Vaccinium* and formerly referred to this species does not belong here.

Haunts. The butterfly prefers rocky heaths where *Vaccinium* and other low shrubs grow in patches. It often flies in company with *Cyaniris pseudargiolus lucia*, and is fond of alighting upon rocks or upon dead twigs lying on the ground. Mr. Faxon also says it is partial to the mouse ear (*Antennaria*).

Life history. The butterfly is single brooded and generally makes its appearance toward the end of April or very early in May; in northern localities, about the middle of May; it always precedes *L. irus* by a few days in places where both occur; occasionally it is found shortly after the middle of April and generally begins to be abundant during the first week in May; it continues to fly during this month and rubbed specimens are occasionally found during the first half of June. Mr. Bowles has even taken it in Quebec late in June. It lays its eggs in the latter half of May, and the caterpillar probably attains maturity in the latter part of June; Mrs. H. Edwards obtained two fully grown on July 12 at Summit Station in the Sierra Nevada, which went into chrysalis July 15 and 17; the chrysalis then remains unchanged until spring.

Habits, flight and postures. It invariably flies very low, even though alarmed, seldom rising more than a foot or two from the ground. Its natural movement is rather feeble, slow and fluttering; it flies only a short distance and frequently alights. But when two come together, their flight is quite bewildering, circling about each other as they do with such rapidity that the eye can scarcely follow them.

It is very fond of alighting upon dead twigs, and one can but notice at such a time how closely the colors of the under surface, as it sits with erect wings, resemble those of a dead leaf or stick; indeed, the appearance of the butterfly when the woods are still bare of leafage seems to render such a protective resemblance the more important to it.

On alighting, the butterfly at once begins rubbing the upraised hind wings backward and forward over each other, their extremities moving

over a space equal to about a fourth or a fifth of their width; the insect frequently sidles about—even during this action—with a twitching movement, as if seeking a suitable place of rest, though this is done without reference to the sun.

Desiderata. This insect has never been reared and the egg and early stages of the larva as well as its habits are quite unknown. Even the food plant has yet to be found, for the only caterpillars we know were found full fed on the rocks. One should watch the action of the females during June, especially about Ericaceae or Rosaceae, which are perhaps more likely than other plants to prove its food. Our knowledge of the geographical distribution of the butterfly leaves much to be desired, for on account of its early flight and easy disguise it has, no doubt, been overlooked in many localities where it occurs.

LIST OF ILLUSTRATIONS.—*INCISALIA AUGUSTUS*.

<i>General.</i>	
Pl. 23, fig. 5. Distribution in North America.	Pl. 34: 32. Male abdominal appendages.
<i>Imago.</i>	46, fig. 24. Androconium.
Pl. 6, fig. 25. Female, both surfaces.	53: 1. Side view with head and appendages enlarged, and details of the structure of the legs.
13: 3. Both surfaces.	

URANOTES SCUDDER.

Uranotes Scudd., Bull. Buff. soc. nat. sc., III: 107 (1876).	Thecla pars Auctorum.
Callipareus Scudd., Syst. rev. butt., 30 (1872).	(Not Callipareus Bon., 1851.)
	Type.— <i>Strymon melinus</i> Hübn.

The dandy Butterfly,
 All exquisitely drest,
 Before the Daisy's eye
 Displays his velvet vest:
 In vain is he arrayed
 In all that gaudily show;
 What business hath a maid
 With such a foppish beau?
 SUTTON.—*The Daisy*.

Imago (54:9). Head rather small, densely clothed with scales, which above are greatly elevated and curve forward, and on the upper part of the front moderately supplied with rather long, coarse hairs. Front scarcely tumid below, sunken above, especially in a short and broad shallow groove down the middle, in no part, excepting below, advanced as far as the front of the eyes; nearly half as high again as broad, nearly or quite equalling the eye in breadth as seen from the front; upper border not raised in the middle, but infringing on the more elevated vertex, the corners considerably hollowed in front of the eyes; lower border very strongly arched. Vertex slightly tumid in the middle, higher than the summit of the front, forming, on either side, pretty large, gradually swollen buttresses to the bases of the antennae, and separated from the occiput by a straight, broad and rather deep, transverse channel. Eyes rather large and full, sparsely pilose, excepting on the posterior fifth, with moderately short hairs, longer beneath. Antennae placed in the middle of the anterior half of the summit, or a little in advance of it, and separated by a space fully equalling the width of the second antennal joint: considerably longer than the abdomen, consisting of thirty-two joints, of which thirteen or fourteen form the club, which is nearly four times as broad as the slightly compressed stalk, increases very gradually

in size to near the tip, where it ends in a bluntly rounded yet slightly angulated apex, four joints entering into the diminution of size; it is nearly five times as long as broad, and rather strongly depressed. Palpi slight, nearly half as long again as the eyes, the terminal joint a little longer than the penultimate and scarcely clothed with scales, while the other joints are furnished on the under surface with a considerable mass of long scales and a few hairs, all compressed in a vertical plane.

Patagia exceedingly long and slender, scarcely arched and not tumid, but with a longitudinal, transversely rounded ridge, a little removed from the inner border; four or five times as long as broad, the basal half tapering slightly, the apical half equal, half as broad as the base, the apex bluntly rounded.

Fore wings (39:12) scarcely more than half as long again as broad, the costal border expanded somewhat at the very base, beyond straight three-fourths of the way to the tip, which is then curved slightly backward. Outer border roundly and slightly bent at the tip of the upper median nervule (δ), or at the tip of the lower subcostal nervure and a little more prominently (φ), the general course of the border being at an angle of about 45° with the middle of the costal border; inner border straight, the angle rounded. Costal nervure terminating scarcely beyond the tip of the cell; subcostal with three superior branches, the first arising a little beyond the middle of the upper border of the cell, the second half way between this and the third, which arises just before the apex of the cell, the main branch flexed downward in the least possible degree between its origin and the cell termination; veins closing the cell very obscure throughout. Cell slightly more than half as long as the wing and fully four times as long as broad.

Hind wings with the basal half of the costal border pretty strongly bowed, beyond nearly straight, and then curved backward to the tip of the upper subcostal, where it joins the curve of the outer border with a well rounded, regular curve (φ), or with a rounded, somewhat abrupt angle (δ); the outer border is a very little convex, more so in φ than in δ , the prominence of its upper portion in the latter diminishing the curve. At the tip of the middle median nervule is a minute, short tail, and at the tip of the lower median a very long, thread-like tail, nearly twice as long as the width of the interspace at its base; the inner border is nearly straight beyond the basal expansion, but very broadly and slightly excised just before the apex, where the angle is abrupt but rounded off. Submedian nervure terminating on the outer border just next the anal angle; internal nervure terminating a very little beyond the middle of the inner border.

No discal stigma and no androconia.

Fore tibiae about four-fifths the length of the hind tibiae, the fore legs similarly developed in both sexes, the tarsi equal in length to the tibiae; last joint of tarsi either resembling the same part in the other legs (φ); or very small, bearing at its unenlarged tip only a pair of nearly straight spines, the continuation of the row at the sides, and having its upper surface covered with very short and close hairs (δ); there is greater disparity between the tarsal spines and spurs in the female than in the male, the spines in the latter being spur-like, but little shorter than the spurs; otherwise, and excepting that in both sexes the tibial spurs are naked, the fore legs are like the others. Hind and middle femora very thinly fringed with hairs; middle tibiae scarcely shorter than the hind pair, armed beneath with a few very small, scattered spines, and at the tip with a pair of not very long spurs, half concealed by scales. First joint of tarsi equalling the succeeding three, which diminish regularly in size, the fifth scarcely longer than the fourth; armed beneath as in the preceding genus, the spines more abundant beyond the first joint; under surface of all the joints but the basal bare of scales. Claws small, compressed, tapering, finely pointed, not very strongly nor regularly curved; paronychial simple, rather stout, equal, nearly as long as the claw, curving a little in a direction opposite to that of the claw; pulvillus minute, projecting.

Abdominal appendages; upper organ with moderately broad, well rounded alations, the two halves separated on the median line above by a broad, rather shallow notch,

curving to a point in the middle, furnished with strongly recurved lateral arms; clasps scarcely so long as the upper organ, straight, not very slender, tapering throughout, rounded at tip.

Egg. Echinoid shaped, not quite so strongly flattened as in *Thecla*; the surface covered with minute polygonal cells, separated by coarse, stout walls, becoming coarser and rather more elevated on the sides and here occasionally raised into prominences. Micropyle not sunken, inconspicuous.

Chrysalis. Viewed from above, the outline of the body is much as in *Thecla*, but the division between the thorax and abdomen is obliterated, or is only distinguishable by the slightly narrower shape of the thorax, which does not taper posteriorly, and the curve of which is interrupted by the slightly and very broadly protruding basal wing prominences—the widest part of the thorax. Viewed laterally, the thorax, which occupies half the body, is separated from the abdomen by a small, rounded hollowing, is most prominent just behind the middle of the mesonotum, in front of which it slopes forward and downward, but little curved to the anterior extremity; the abdomen is well and regularly arched, highest, and scarcely higher than the thorax, at the third segment, the posterior extremity curving rapidly downward, well arched to the posterior extremity, more rapidly than in *Thecla*, and yet with no part perpendicular; transversely the thorax is much as in *Thecla*; the abdomen is also much the same, but a little more depressed and with the sides rather sloping than rounded, being somewhat obliquely compressed above; three-fifths of the tongue exposed; basal wing prominences consisting of very broad, round, but little and gradually elevated swellings. Inner portion of the posterior border of the wings produced posteriorly a little. Whole body covered equally with an interlacing, not very delicate, obscure network of scarcely raised lines, indistinct even under a strong lens, their points of intersection not raised, but bearing straight, short, spinuliferous hairs; the latter are longer in front than on the body generally. Hooklets as in *Thecla*, but the tip not so broadly expanded nor so closely appressed to the stalk.

This is a North American genus, composed, as far as I am aware, of the single species here described, whose geographical distribution will be elsewhere detailed. It reaches its northernmost limits in New England.

The butterfly is of the same size as the species of *Thecla* and of much the same form, but with more angulated fore wings, and the males have not the discal spot upon the fore wings. Above they are bluish brown, their hind wings with an orange spot between the base of the two tails, enclosing one of black and both repeated beneath. The under surface is gray with a transverse stripe, black within, white without, crossing the middle of the outer half of the wing, and toward the anal angle of the hind wings forming a small W.

The insect is probably double brooded in the north and triple brooded in the south, hibernating as a chrysalis. It is a long lived insect, and is seen on the wing almost the whole season. The larva appears to feed on a great variety of plants and the chrysalis state in the south lasts fourteen days.

The caterpillars closely resemble those of *Thecla*, and judging from Abbot's drawings are of a pinkish color above, greenish below, with dusky dorsal and lateral stripes, the latter consisting of a series of short oblique dashes.

The chrysalis is similar to those of *Thecla*, of lighter color, with darker longitudinal markings.

EXCURSUS XXIX.—THE PROCESSION OF THE SEASONS.

Among the falling leaves some birds yet sing,
And Autumn has his butterflies like Spring.
LANDOR.

NO ONE can observe butterflies in the most casual way without having forced upon him the constant fluctuation of forms that greet his eye. At one time he will be struck by the abundance of kinds and of individuals; then by the small number he will meet, mostly of two or three sorts. One common kind he will fancy he has lost sight of, only to have crowds of them burst on him later in the season. He will look for the reoccurrence of others in vain. And each succeeding year he will note the same phenomena in the same order, varied only by the greater abundance or scarcity of one kind or another.

This supplanting of one species by another is in wonderful adaptation to the parallel changes going on in the vegetable world, especially among the flowers. I do not know that any of our naturalists or artists have written of the harmony between the prevailing tints of a New England landscape at different times of the year, and of the insect world at the same seasons. Our common butterflies, which nature has been at such pains to adorn, show a shifting panorama of form and color from early spring to the time of frost. First, in the sombre leafless woods come the various dusky wings, brown and black, skipping softly in and out among the gray rocks and over the dry leaves and dark pools of melting snow, or sunning themselves on dry sticks athwart the sun. Hard upon these, in the time of early violets and hepaticas and frequenting the spots most loved by them, follow the little blue butterflies, scarce larger than the flowers. Then, as spring fairly bursts upon us with its fresh and varied hues, come crowds of queenly swallow-tails, lustrous with metallic gleam, or striped and belted with gay colors; and the banded and spotted purples that court the quiet forest road and the brink of the mountain brook; the soft white butterflies, that look too pure for earth, less retiring than the last, float about our gardens, alas! on sad intent; while the brisk little tawny and black skippers everywhere bustle and whisk about. Summer, with its blazing sun and diversified blossoms, brings us the hot-looking coppers, and all that dappled band of fritillaries and angle-wings, blocked in red and black above, and often variegated by odd dashes and spots of burnished silver, or by peacock eyes beneath. How they crowd about the spreading thistle blossoms, or on the many-flowered umbels of the milk weed, and fan themselves with content at their sweet lot! As autumn

approaches and the leaves grow dull, the grain ripens in the meadow and the pastures parch with drought, then come the satyrs or meadow-browns, lazily dancing by the roadside and over the thickets which skirt the fields; in the time of golden rods and yellow and blue asters the great throng of yellow and orange butterflies appear; some of them are with us throughout the season, companions of the buttercup, the dandelion, and the rudbeckia; but now they swarm, flitting busily in zigzag courses over upland pasture and lowland meadow, by marsh and brook, in field and fen, crowding around the open flowers, or dancing in pairs in mid-air.

* Compare some similar observations on the seasonal succession of European moths by Wernburg in his *Der Schmetterling und sein Leben*. Berlin, 1874. See pp. 116-117.

URANOTES MELINUS.—The gray hair streak.

[Red spotted hair streak butterfly (Abbot); hop vine thecla (Harris); hop butterfly, hop-eating thecla (Emmons); gray hair streak (Scudder); gray streaked butterfly (Maynard).]

Strymon melinus Hüb., Zutr. exot. schmett., i: 22, fig. 121-122 (1818).

Thecla melinus Westw.-Hewitts., Gen. diurn. Lep., ii: 486 (1852).

Callipareus melinus Scudd., Syst. rev. Amer. butt., 30 (1872).

Uranotes melinus Scudd., Bull. Buff. soc. nat. sc., iii: 107 (1876); Butt., 130, 308, fig. 124 (1881).

Thecla melinus var. *pudica* H. Edw., Pac. coast Lep., 113 [22: 10] (1876).

Polyommatus ergeus God., Encycl. méth., ix: 601, 635-636 (1819).

Thecla hyperici Bois.-LeC., Lép. Amér. sept., 90-91, pl. 28, figs. 1-5 (1833);—Morr., Syn. Lep. N. Amer., 94 (1862).

Thecla favonius Bois.-LeC., Lép. Amér. sept., 95-98, pl. 30, figs. 1-5 (1833);—Morr., Syn. Lep. N. Amer., 95-96 (1862).

Thecla pan Harr., Hitchc. rep. geol. Mass., 590 (1833).

Thecla humilis Harr., Ins. inj. veg., 1st. ed., 215-216 (1841); 3d. ed., 276-277, pl. 4, fig. 3 (1862);—Emm., Agric. N. Y., v: 214 (1854);—French, Rep. Ill. ins., vii: 157 (1878); Butt. east. U. S., 259 (1886);—Fern., Butt. Me., 78 (1884);—Mayn., Butt. N. E., 34-35, pl. 4, figs. 32, 32a (1886).

Thecla silenus Doubl., 1st Lep. Brit. Mus., ii: 31 (1847).

Papilio———Abb., Draw. ins. Ga., Brit. Mus., vi: 49, figs. 160, 161; xvi, 37, tab. 176 (ca. 1800).

Figured also by Abbot, Draw. ins. Ga., Gray coll., Bost. soc. nat. hist., 57; Oemler coll., ibid., 23;—Glover, Ill. N. A. Lep., pl. 28, fig. 6, ined.

(Not *Pap. favonius* Smith-Abbot; nor *Pap. pan* Drury.)

Why, I have been a butterfly, a lord
Of flowers, garlands, love-knots, silly postles,
Groves, meadows, melodies, and arbour roses.

KEATS.—*Endymion*.

She dances feently.

SHAKESPEARE.—*Winter's Tale*.

Imago (6: 20; 14: 13). Head covered with snow white scales, the front with a large, quadrate space (which reaches neither the eyes nor the antennae, and leaves a large patch above the tongue) filled sparsely with dark brown or blackish hairs, and sometimes also with paler scales, so as, in the latter case, to form a plumbeous patch; space behind the antennae blackish brown, and with the basal antennal joint inconspicuously edged with short, blackish hairs; the back of the head, especially the upper portion of the sides, covered with blackish scales; vertex, together with the overarched hairs in the middle of the posterior part of the head, bright orange. Antennae blackish brown, the joints of the stalk and of the proximal part of the club annu-

lated at base, narrowly above, broadly beneath, with white; becoming confluent at the base of the club beneath, and forming a short, broad white patch; terminal four or five joints of the club orange, sometimes obscured by fuscous—at least in dried specimens. Palpi snow white, the basal joint very narrowly tipped outside with a transverse streak of blackish brown, which reaches the lower corner of the eye; upper surface of the terminal joint to the very tip, and sometimes also the tip of the penultimate joint dark brownish fuscous. Tongue luteo-fuscous at base, beyond fuscous.

Thorax blackish brown, covered abundantly with very delicate, not very long, erect or suberect, steel blue hairs, changing into brownish in the longer recumbent hairs of the posterior portion, or changeable throughout, the blue most conspicuous in front, the brown behind; patagia edged with same, paler; beneath the thorax is covered with dull white hairs, with a very pale bluish reflection. Femora nacreous, the inferior tuft of white hairs with a few intermingled dusky ones; tibiae and first joint of tarsi brownish fuscous, annulated at tip with white, beneath dull luteous; spines black; claws and spurs dark yellowish brown, the former dark reddish on apical half.

Wings above bluish black, by reflected light with a very dark mulberry lustre, the veins, especially of the hind wings, often blacker. On the middle of the *fore wings* a very large, faint, quadrate, cloudy spot of slightly darker scales (not confined to either sex, but apparently more distinct in the female), its corners rounded, extending from just below the costal border to, and just over, the lower median nervule; it is nearly twice as long as broad, and is directed from the middle of the costal border toward the lower outer angle, and therefore not quite at right angles to the former; outer border of all the wings narrowly lined with blackish. On the *hind wings* this is surmounted in the median interspaces and below by a line of bluish scales, and, after a narrow interval (filled with a blackish spot in the medio-submedian interspace) by a second line; in the lower median interspace, however, there is a large, high, conspicuous, orange lunule, and in the medio-submedian interspace the upper blue line is often surmounted by a small, blackish spot, occasionally supplanted by orange; the extreme anal angle has an inconspicuous orange spot enclosed between the black border line and an upper and outer edging of bluish scales, and nearly concealed by the soft brown hairs of the lower half of the wing; fringe blackish fuscous at base, whitish, sometimes obscured with fuscous, at tip, below the tail of the hind wings, blackish also at tip, with a median whitish line.

Beneath uniform, soft, pearly, rather dark, clay brown, occasionally with a decided bluish tinge, the outer border distinctly lined with black; costal edge at base fulvous. *Fore wings* with a transverse stripe of nearly continuous black or blackish brown streaks, bordered externally with white, and sometimes with a slight gleam of orange on the inner side, running from the costal border, at a point a little beyond the middle of the outer half to the lower median nervule, at about two-thirds the distance from its base; the general direction is a slight curve, neither parallel to the outer border nor at right angles to the costal margin, but about midway between the two; at an interspace's distance from the outer border is a series of more or less distinct, ill-defined, fuscous or blackish, transverse streaks, often obsolete over a portion of the wing. In the middle of the outer two-thirds of the *hind wings* is an irregular, but nearly straight, transverse series of spots like those of the extra-mesial series on the fore wings, but usually bordered distinctly within with reddish orange; in the upper part of the wing, as far as the lower median nervule, its general direction is straight, subparallel to the outer border, broken invariably at the upper median nervule by having its lower portion bent inward; in the medio-submedian interspace the stripe forms a slight λ , the limbs bent at right angles, the lower one, if either, the longer, and followed, in the lowest interspace, by a long, curved, and, at the lower end, sinuous streak, terminating on the inner angle a little more than half way from the base to the tip; these latter markings form a rather obscure W. Beyond this band, parallel to the outer border and distant from it by the width of an interspace, is a series of ill-defined, blackish fuscous, transverse streaks as far as the middle median nervule, usually increasing in size downward, and occasionally merging into or enclosing

orange; in the lower median interspace there is a very large orange spot, enclosing at its lower edge a roundish black spot, and edged narrowly above with black, usually just meeting above the outer V of the W in the mesial band, and not reaching below the outer border; in the next interspace below, a little less than midway between the mesial band and the outer border, is a transverse black streak, edged above by bluish white scales, and followed by bluish atoms sprinkled more or less profusely on a blackish ground, reaching the outer border, but abridged above to a greater or less extent by some orange color on either side, occasionally traversing the whole width of the interspace; the lowest interspace has, again, an orange spot, continuous with the orange of the interspace above, limited superiorly by a curved blackish streak, which is edged above with bluish white, and directed inward as it passes toward the inner border, and below by a pretty large, blackish spot, occupying the extreme anal angle; the black edging of the outer border of the wing is surmounted by a narrow line of whitish scales, most distinct on the lower half of the wing, and occasionally suffusing somewhat the bluish spot in the medio-submedian interspace; fringe of both wings similar in color to the under surface of the wings, or slightly paler, black at the extreme anal angle of the hind wings, and black-tipped in the adjoining interspace; tails blackish brown, white-tipped, the longer also fringed interiorly on basal half with white.

Abdomen above and half way down the sides of the color of the upper surface of the wings; lower half of the sides grayish, beneath whitish. Alations of upper organ of male (34:20) well rounded, but angularly produced a little, and slightly notched at the lower posterior angle; clasp tapering regularly throughout, bluntly rounded at tip, the lower edge straight, the whole less than three times as long as broad.

Measurements in millimetres. Length of tongue, 7 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	14.75	15.5	16.	13.75	15.	15.
antennae.....	7.	7.75	8.	6.8	7.25	7.35
hind tibiae and tarsi...	4.25	4.6	4.75	4.2	4.75	4.75
fore tibiae and tarsi..	3.25	3.5	3.5	3.2	3.5	3.5

Described from 18 ♂, 10 ♀. Tails varying from 3.25-4.5 mm. (♂) in length.

Variations. The typical specimen of *Thecla humuli* in the Harris collection, like one other from New England I have seen, has so small an orange spot in the lowest median interspace of the under surface of the hind wings, as to give a very different appearance to the insect. The spot reaches only half way to the band; it was doubtless this circumstance added to the difference in the length of the tails that led Dr. Harris to consider his northern specimens specifically distinct from the southern.

Eastern examples seem to be slightly smaller than those from the Pacific coast, the color of the upper surface of the wings is darker and richer, that of the under surface somewhat darker; while the Californian specimens, which are soft, pearly gray beneath, generally have the orange edging of the mesial band more distinct and broader. It is a little curious that Edwards, who looks upon the Californian form as a species distinct from the eastern, should refer Hübner's *melinus* to the Californian species, when the specimen from which the illustration was taken came from Georgia.

Egg (65:5, 6). Pea green, the cells about .03 mm. in diameter, polygonal, above often quadrangular or nearly so, scarcely growing smaller next the micropyle, the walls on upper surface about as high as thick and about one-sixth the average diameter of the cells; on the sides at least twice as thick, the cells sometimes reduced to circular pits and, at the angles of several cells, the walls raised to a low, rounded, knob-like prominence still at the same distance apart as above. Micropyle (68:3) indicated by the lowering of the cell walls about it, itself of slight dimensions, composed of a single circle of six wedge-shaped cells, together .05 mm. in diameter. Diameter of egg, .6 mm.; height, .36 mm.

Caterpillar. *Last stage* (75: 27). Dark, dingy, velvety brown, apparently with no markings whatever, the dorsal region flattened in a narrow field, which is less profusely covered with the long bristly hairs which cover all parts of the body and appear to be most abundant and longest on the larger front segments and on the laterodorsal angle marking the limitation of the dorsal flattened region; they are mostly directed backward, tapering regularly, straight or scarcely curved, pale or dark testaceous, deepening sometimes into blackish and occasionally pale tipped but generally luteo-testaceous at the base and deepening in color to a greater or less extent apically; the longest are not so long as the abdominal segments and they are minutely, distantly and most briefly furnished with subrecumbent spicules. Length, 6.8 mm.; breadth, 2.4 mm. Length of longest hairs about 5 mm.

Described from a dried specimen, found by Mr. A. C. Sprague at South Hadley, Mass., in August, 1886, on *Cynoglossum*. According to Mr. Sprague they were brownish when small, afterwards reddish, and before transforming purplish white. They did not hatch but were determined from the chrysalis.

Chrysalis (84: 39). Luteo-testaceous, strongly discolored with blackish fuscous on the sides of the thorax and flecked with the same on the sides of the abdomen, on the latter especially about a series of small round black spots in the centre of the first six segments in a lateral series; a similar black spot occurs along the median line on the front edge of the pronotum, and the hind edges of both pro- and metanotum, in the latter case extending also across the first abdominal segment; also on the produced hinder edge of the metanotum laterally next the wings; a fine impressed line down the middle of the mesonotum. The dorsal portions of the wings are more or less flecked with the darker markings, but beneath, like the rest of the under surface which has a slight but warm reddish tone, the markings are reduced to scattered, obscure, fuscous dots. The elevated tracery of the surface is usually of the tint it covers, but on the abdomen including the dorsal portion it is more or less deeply infuscated and the mamillate bases of the hairs are everywhere more or less infuscated. The hairs are short, nowhere equalling one-third the length of the abdominal segments, luteo-testaceous at base, dusky at tip. Length, 9 mm.; breadth of thorax, 3.85 mm.; of abdomen, 4.25 mm.

The single specimen seen was obtained by Mr. A. C. Sprague from a larva taken on *Cynoglossum* at South Hadley, Mass.

The following description was drawn up many years ago from the shell of a chrysalis raised by Dr. Harris.

Dull wood brown, faintly obscured with irregular, small blotches of fuscous; the abdomen tinged with yellowish; edges of the segments both of thorax and abdomen and the edges of the appendages a little infuscated; a blackish fuscous dorsal dash on the metathorax, first and anterior half of the second abdominal segment; lateral central and suprastigmatal, posterior and smaller, blackish fuscous spots on the second to seventh abdominal segments; the net work of raised lines reddish brown, the hairs fusco-luteous, those in front of the body longer and frequently black, usually black tipped. Length, 8.5 mm.; breadth of abdomen, 4 mm.; height of abdomen, 3.75 mm.; length of anterior hairs, .44 mm.; other hairs, .27 mm.

Distribution (23: 6). This widely spread species will probably be found in every part of the United States, excluding Alaska. Strange to say, I have not received it nor found a single notice of its occurrence north of our boundary, excepting that it occurs rarely near Montreal (Lyman), and is found at Vancouver Island (Fletcher); yet along this border it is known in most of New England, at Albany, N. Y. (Lintner), Cleveland and Rockport, Ohio (Kirtland), northern Illinois (Worthington), Wisconsin common (Hoy), Dallas County, Iowa (Allen), Dakota and Mon-

tana (Edwards). It is abundant in all the southern states, occurring in Florida as far south as Indian River (Palmer), Capron and Enterprize (Schwartz) and in Texas at Waco (Beltrage) and the Rio Grande (Lintner, Aaron). It is even recorded by Doubleday as an inhabitant of Venezuela. Godman and Salvin give it from Mexico, Guatemala, Panama and Venezuela and Godart from the Antilles. On the Pacific coast it is found in California, at least in the counties of Contra Costa (H. Edwards) and Shasta (Butler), and also in Nevada, near Truckee (McGlashan) and in Arizona (Edwards). It is not only found everywhere in the great interior of the Mississippi Valley, but apparently in the elevated plateau region, having been brought from Georgetown (Mead), Manitou and Engleman's Cañon, Colorado (Snow) and St. George, Utah (Palmer).

In New England it is more abundant in the south than in the north, but has been found as far as Norway (Smith) and Hallowell, Me. (Miss Wadsworth); in New Hampshire, at Dublin (Faxon), Milford (Whitney) and Suncook, N. H. (Thaxter); while in Massachusetts it has been taken in such elevated places as Mt. Toby (Sprague), Amherst Notch and Princeton (Scudder) and the top of Blue Hill (Scudder), besides numerous lower and more southern localities.

Food plants and habits of the larva. In the north this caterpillar appears most frequently to be found on the hop (*Humulus lupulus* Linn.), devouring the heads and causing much injury (Harris); indeed in some places, farmers have on this account abandoned all attempts to raise the plant. In the south Abbot states that it feeds on "parsley haw" (*Crataegus coccinea* Linn. is figured, and *C. apiifolia* is mentioned in Boisduval's notes), pine and snap beans (by which Dr. Chapman says common garden beans are meant). According to Boisduval and Le Conte—on Abbot's authority—it lives on *Hypericum* (*H. aureum* is the species mentioned on the original), and hence they named the species *hyperici*. Finally Mr. A. C. Sprague found the larva in central Massachusetts, on *Cynoglossum officinale*. Such a variety of food plants seems extraordinary; each belongs to a separate family and the *Hypericaceae* and *Coniferae* are nearly at the antipodes of exogenous plants.

The caterpillars found on *Cynoglossum* were very active when young, stretching themselves out in walking so as to be very slender and then contracting so as to be little more than an eighth of an inch in length. They feed upon the pods of the plant.

Life history. It is the only one of our *Theclidi* which flies almost continuously from May to September, being apparently rather long lived; as far as we can judge it is double brooded, the insect wintering in the pupal state; it first appears in the early days of May and may be seen throughout this month and part at least of June; a new brood makes its advent

early in July, or even by the very last of June, and flies not only through July, when the wings become rubbed, but also through August and occasionally even until the middle of September. Mr. F. H. Sprague has even taken one October 10, at Wallaston, Mass.

The caterpillars found by Mr. A. C. Sprague on *Cynoglossum* were taken at the end of August in all stages. Some of them changed to chrysalis toward the end of September, so that it is probable that it hibernates in the pupal state. In the extreme south, judging from Dr. Chapman's extensive memoranda and other notes, the butterfly is seen from the middle of March to the middle of November and unless the broods follow each other with such rapidity as to become entirely confounded, his statements would seem to indicate three broods, appearing about the middle of March, the middle of June and the middle of September, undoubtedly overlapping and growing successively more numerous in individuals; but specimens taken by Palmer at Indian River, Florida toward the end of March were rubbed and ragged, so that in central Florida it probably appears by the first of March. The duration of the chrysalis state is fourteen days, according to a single observation by Abbot.

The butterfly may be found about bushes and hop vines, and on *Lespedeza*; it is very common in the south, and not infrequent in the north. In South Carolina I found it in little companies of five or six, dancing rapidly in and out among *Coniferae*, six or eight feet above the ground.

Parasites. One of the chrysalids raised by Mr. Sprague on *Cynoglossum* gave birth to a parasite, *Anomalon pseudargioli*.

Desiderata. Our knowledge of the seasons of this insect in all its stages and of the exact apparition of the successive broods of the butterfly, either in the north or south, can by no means be considered as satisfactory; the time of deposition of eggs, their duration and that of the pupa (in the north) are wholly unknown; even the condition in which the insect hibernates is not proved. We have then scarcely a single satisfactory datum whereon to build the history of this insect. Its habits, haunts and flight equally need investigation and a description of the young larva is most desirable.

LIST OF ILLUSTRATIONS.—URANOTES MELINUS.

- | | |
|--|--|
| <i>Egg.</i> | <i>Imago.</i> |
| Pl. 65, fig. 5. Surface sculpture. | Pl. 6, fig. 20. Female, both surfaces. |
| 6. Side view of egg. | 14:13. Both surfaces. |
| 68:3. Micropyle. | 34:20. Male abdominal appendages. |
| <i>Caterpillar.</i> | 39:12. Neuration. |
| Pl. 75, fig. 21. Full grown caterpillar. | 54:9. Side view with head and appendages enlarged, and details of leg structure. |
| <i>Chrysalis.</i> | <i>General.</i> |
| Pl. 84, fig. 30. Side view. | Pl. 23, fig. 6. Distribution in North America. |

MITURA SCUDDER.

Mitura Scudd., Syst. rev. Am. butt. 31 (1872). Thecla pars Auctorum.

Type.—*Thecla smilacis* Boisduval. LeC.

Malheur, papillons que j'aime,
Doux emblème,
A vous pour votre beauté!...
Un doigt de votre corsage,
Au passage,
Froisse, hélas! le velouté!...

Une toute jeune fille,
Au cœur fendre, au doux souris.
Perçant vos cœurs d'une aiguille.
Vous contemple, l'œil surpris:
Et vos pattes sont coupées
Par l'ongle blanc qui les mord,
Et vos antennes crispées
Dans les douleurs de la mort!...

DE NERVAL.—*Les Papillons.*

Imago (54: 10). Head rather small, densely clothed with scales, which are longer above, and rather abundantly furnished with moderately long, curving hairs, both above and in front. Front rather full, the middle longitudinal half being tumid, and increasingly so from above downward, considerably surpassing the front of the eyes throughout and especially below; at the upper extremity a short, narrow groove down the middle; the piece is slightly less than half as high again as broad, and fully as broad as the eye on a front view; the upper margin is raised to a scarcely perceptible transverse ridge, the corners considerably hollowed in front of the eyes; lower margin strongly and rather broadly convex, subquadrate; vertex nearly flat in the middle, not higher than the front, at the sides developed into broad, tumid enlargements behind the antennae, and separated from the occiput by a broad and deep, straight, nearly uniform, transverse channel, with a small, central, circular pit. Eyes rather large and full, very sparsely pilose with not very long scattered hairs, becoming longer below and wanting above. Antennae inserted in the middle of the anterior half of the summit, and separated from each other by a space equalling the width of the basal antennal joint; considerably longer than the abdomen, consisting of twenty-eight joints, of which eleven or twelve form the rather strongly depressed club, which is scarcely three times as broad as the stalk, about five times as long as broad, increasing in size very gradually and mostly on the outer side, tapering more rapidly over the last four joints, the last bluntly rounded. Palpi scarcely half as long again as the eye, moderately slender, the apical joint about three-quarters the length of the penultimate, and furnished with recumbent scales, the other joints heavily clothed with moderately large and long scales, and provided besides, along the under surface, with a thin fringe of rather long, coarse hairs, all in a vertical plane.

Patagia very long and slender, a little arched and tumid, nearly four times as long as broad, the basal half tapering slightly, the apical half equal, half as broad as the base, the apex bluntly rounded.

Fore wings (39: 14) fully two-thirds as long again as their width, the costal margin strongly bent a little way from the base, beyond straight, at the very tip bent slightly backward, rounding off the outer angle, the outer margin very broadly and regularly curved, the inner margin straight. Costal nervure terminating a little beyond the tip of the cell; first superior subcostal branch arising a little beyond the middle of the cell; the second either half way (♀), or not over one-quarter way (♂), to the tip of the cell; the third, either at the tip of the cell (♀), or very shortly beyond the second (♂); the main stem either straight beyond the origin of the first branch (♀), or curved downward pretty strongly beyond the origin of the second branch, slightly upward again beyond the apex of the cell, and then straight (♂); cross vein closing

the cell either nearly transverse, the two halves scarcely bent and very feeble, excepting next the main branches, striking the subcostal opposite the origin of the last superior branch (♀); or strongly bent, the lower half transverse and feeble, the upper oblique and strong, striking the subcostal nervure farther beyond the origin of the last superior branch, than that is beyond the first (♂). Cell scarcely half as long as the wing and more than three times longer than broad.

Hind wings with the costal margin considerably and roundly expanded at base, nearly straight in the middle half, beyond curving gradually backward, broadly rounding the outer angle; outer margin rather broadly and regularly rounded, slightly fuller in the ♀ than in the ♂, with a slender, thread-like tail at the lower median nervule, half as long again as the width of an interspace at its base, and with a secondary tail at the middle median nervule, forming only a slight, not slender projection; inner margin not very broadly convex, roundly and not deeply emarginate just before the tip. Submedian nervure terminating on the outer border, just beyond the anal angle; internal nervure terminating beyond the middle of the outer border.

Androconia remarkably stout, less than three times as long as broad, quadrangular, with equal sides, the stalk very short.

Fore tibiae from three-quarters to four-fifths the length of the hind tibiae, and of the same length as the fore tarsi; fore legs similarly developed in the two sexes, excepting the last tarsal joint, which is either like that of the other legs (♀), or very small, bearing at its unenlarged tip only a pair of nearly straight spines, the continuation of the row at the side, and having its upper surface covered with very short and close hairs (♂); otherwise, and excepting that in both sexes the tibial spurs are naked, the fore legs differ from the others in little but their size. Femora thinly fringed with hairs, rather more thickly on the fore legs, and especially in the male; middle tibiae but little shorter than the hind pair, armed at the tip with rather short spurs, almost completely concealed by scales, but with no spines, or at least none that emerge above the scales; first joint of tarsi equalling the three succeeding, the second and third equal, shorter than the fifth and longer than the fourth; armed beneath, on either side, with a clustered row of small, crowded, rather slender spines, a single one on either side of the apex of each joint longer and spur-like; under surface of all the joints but the basal devoid of scales. Claws small, compressed, slender, tapering, finely pointed, rather strongly and regularly curved; paronychial simple, rather stout, equal, as long as the claw, nearly straight; pulvillus very minute, projecting.

Male abdominal appendages having the upper organ much as in *Thecla*, but cleft above in such a way that the notch terminates sharply; the lateral arms are less delicately pointed. Claspers gibbous at base, tapering rapidly beyond to a finely drawn out point.

Egg. Greatly depressed echinoid-shaped, as broad at summit as at base, the summit slightly depressed; studded abundantly with rather large, greatly elevated conical prominences, connected with the neighboring ones by rather obscure and slight but somewhat coarse ridges, which run up the sides of the prominences as buttresses and give them the appearance of miniature volcanic cones; to some extent they are disposed in regular rows. Micropyle rosette not greatly depressed, rather large, composed of a number of nearly uniform oval cells, divided by delicate lines.

Caterpillar at birth. Body much as in *Thecla*. Laterodorsal series of hairs consisting of two nearly equal, centrally situated papillae, side by side, the hairs borne by them spiculiferous and of equal length; and besides these a supralateral series at the anterior margin, supporting a shorter hair. In this genus is also found a laterostigmatal series of papillae similar to the last mentioned and situated like them at the anterior margin, bearing a spiculiferous hair but slightly shorter than those of the laterodorsal series. Beneath the stigmata is on each segment a cluster of four papillae, bearing hairs of nearly equal length directed outward and about half as long as the width of the body.

Mature caterpillar. Body largest anteriorly, very gently tapering, the last or last

two segments more rapidly, the last rather broadly rounded and at extreme tip subtruncate; each segment rather strongly hunched, falling off abruptly at posterior margin, with three median depressions, one very slight and dorsal, one more distinct and lateral, and one much deeper and connecting with the one above so as to form with it a C, open anteriorly, at the deepest part of which the broadly obovate spiracles are situated; on the second thoracic segment, the upper two depressions run together into a transverse sulcus; and the first thoracic segment is marked posteriorly by a very deep, dorsal, transverse, lozenge-shaped depression with emarginate sides, and in front of it a central dent; anteriorly this segment is tumid; pile of uniform length all over the body.

Chrysalis. Differing in form from that of *Thecla* in the considerably greater inequality of the cephalothoracic and abdominal masses, the abdomen being fuller and shorter, more shortly and stoutly oval, the parts in advance tapering more rapidly, scarcely interrupted by the rounded basal wing tubercle and nowhere equal, to a narrower head; in particular the tip of the abdomen is more regularly rounded, and the thorax more compressed. Hair-bearing papillae higher than broad, scarcely broader than the bases of the hairs which are short and spiculiferous. Tracery of raised lines as in *Thecla*.

This American genus probably occupies all the eastern part of the northern continent south of the isotherm of 50°, including the Antilles; a single species occurs in the eastern United States and finds its northern limits in the southern half of New England.

The butterflies are of nearly the same size and shape as those of *Thecla*, and resemble them also in having an oval disk on the fore wings of the male and two unequal tails on the hind wings; they are dark brown above, having the disk more or less deeply suffused with yellowish brown. Beneath they are deep green, the fore wings traversed by a straight submarginal white stripe, bordered interiorly with brown; a similar but tortuous and extra-mesial stripe occurs on the hind wings, which are also provided with a few white dashes at the base and some brownish spots next the outer margin.

The butterflies are double brooded, appearing (at least in the north) in May and August and hibernating in the chrysalis state. They are very active.

Gosse, speaking of a Jamaican species, says:—

It pursues its game of aerial play with its fellows in incessant and unwearied pertinacity, half a dozen or more whirling about each other in the air with a rapidity of contortion that the eye of the observer vainly attempts to follow. Often two or three will begin to play around an orange tree and in a few seconds others which we had not seen before, coming from no one knows where, suddenly join in the gambols and thus the little group increases to eight or ten which after a while separate and disperse invisibly as they came. Their small size and great rapidity of motion doubtless help to produce this effect. They delight in the full beams of the burning sun; the hottest part of the day is the season of their greatest activity and even the shadow of a passing cloud will spoil their play (*Ann. mag. nat. hist.*, (2) 11: 272).

The eggs are of a greatly depressed echinoid shape, resembling those of *Thecla*, and studded with conical prominences connected by rather coarse ridges.

The caterpillars are rather stouter than those of *Thecla* and with more distinct dorsal and lateral fields. They are green, marked with reddish spots in a dorsal and lateral series. They feed, so far as known, on coniferous and endogenous plants.

The chrysalis is slenderer than that of *Thecla*, the abdomen being as high as the thorax. It is of a brownish color.

EXCURSUS XXX.—THE ADORNMENT OF CATERPILLARS.

There is a difference between a grub and a butterfly; yet your butterfly was a grub.
SHAKESPEARE.—*Coriolanus*.

In this section we propose to speak of the variety and style of coloring found in caterpillars without reference to the meaning or origin of their markings, which we shall discuss separately on a future page. The colors of caterpillars are by no means so various nor the patterns so complicated as is the case with the winged butterflies themselves. But it is nevertheless true that as a general rule the different species may be separated from one another with considerable certainty by their markings and colors alone. With caterpillars the variety of the dermal appendages goes far toward making up the general appearance of the creature, and by their aid, combined with the colors and patterns, the separation of species may probably in all cases be tolerably sure. But excepting in so far as their tints are concerned we have here nothing to do with the appendages attached to the body, but only to the surface of the head and body themselves.

The vast majority of butterfly caterpillars are green, though but exceedingly few of them, if indeed any, are uniformly green throughout. Most of them are longitudinally striped either with lighter and darker shades of green or with yellow or various shades of brown. Many of them have the additional adornment of points of brighter or darker colors, which are almost invariably confined to the little papillae with which the body is almost always studded. Such are the vast majority of the *Satyriinae*, the *Pierinae*, the *Hesperidae* and the *Libytheinae*. These longitudinal stripes are by far more common than elsewhere in the middle of the back, where they mark the course of the dorsal vessel, on the lower portion of the sides, where they mark the alignment of the spiracles, and midway or about midway between these two; when most variegated the stripes are multiplied, especially upon the upper half of the body, and often show a greater degree of intensity at the extreme anterior or extreme posterior end of each segment.

Other green caterpillars are marked with oblique stripes, which gener-

ally part from the darker mediodorsal line at about such an angle, as Lubbock remarks, as the ribs of a leaf part from the main stem. These oblique stripes almost invariably run down the sides from in front backward, generally cross two or three segments, and may or may not join a stigmatal line below or the dorsal line above. Such markings are found almost exclusively among the *Lycaeninae* and here are extremely common.

Some shade of dark greenish brown is a very common ground tint for the caterpillars of butterflies, and these are often longitudinally striped, as is the case with the larger part of the *Argynnnidi*, *Vanessidi*, etc. Here as before the stripes are more common in the neighborhood of the stigmatal line and the dorsal vessel. But they are more commonly broken by the varying intensity of the colors, and are frequently accompanied by an edging, which is but the ground tint intensified at their border. A considerably greater variety is also seen here from the more or less definite arrangement of the differently colored papillae in transverse lines across the body, so that by the combination of these two forms of transverse and longitudinal markings almost any conceivable pattern may arise, and one which may be highly complicated. Thus a bright colored spot marks each segment of the abdomen above in *Euvanessa antiopa*, giving it a very different aspect from the pepper-and-salt coloration of its near ally, *Hamadryas* of Europe.

Then there are those caterpillars which, upon a bright green or olive ground, find all their conspicuous markings in dark stripes encircling or almost encircling the body, and generally especially conspicuous upon the upper surface. Such is notably the case in the genera *Iphiclid*, *Papilio* and *Anosia*, and less so in *Cinclidia* and *Euphydryas*. Or the lighter and darker colors of the body may segregate in a more massive way and exceedingly conspicuous broad bands follow the length of the body, as in some of the *Melitacidi* of Europe; or they may congregate in large dorsal, saddle-like patches, as in all our species of *Basilarchia* and in several of the *Papilioninae*, either in their earlier or later stages. Indeed it is in the *Papilioninae* that we find perhaps upon the whole the most striking and extraordinary freaks of coloring to be found among butterflies, the great variety even among the few genera found in North America being only an intimation of what may be found in tropical regions, where the subfamily is so much more fully represented. The eye-like spots of the swollen anterior segments, colored in such an extraordinary and admirable manner, the opalescent and jewelled dots which besprinkle the dorsal surface, the brilliant fleshy appendages which sometimes adorn the sides, the frequent contrasts of such colors as bright orange and velvety black, not to mention the curious differences in the markings between the earlier and later stages, reveal the possibilities of natural selection in the

adornment of caterpillars. These brilliant colors are perhaps only possible by their possession of protective osmateria.

We have spoken only of the body; yet the head should not be overlooked, for though generally, if not black, of nearly the same color as the body, or of some tint which harmonizes well with it, it not unfrequently has attractive colors and markings of its own which merit a single word. The frontal triangle is one point around which the colors seem often to be symmetrically disposed, and next in importance are the crowning points of the hemispheres into which the head is laterally divided. If important papillae are present, these are frequently colored in some striking contrast with the surface itself, and the surface, sometimes glistening, sometimes dead, is often punctate or rugulose with delicate tracery. Nor should we omit to mention the ocelli, which under the lens are often seen to have colors of striking beauty, and almost always are contrasted with their ground in some striking way by rings of pigment peculiar to them.

MITURA DAMON.—The olive hair streak.

[Green hair streak butterfly (Abbot); auburn Thecla (Harris); the olive hair streak (Scudder); green streaked butterfly (Maynard).]

Papilio damon Cram. Pap. exot. iv: 208, pl. 390, figs. C, D (1782);—Herbst, Natursyst. Ins. schmett., xl: 24, pl. 299, figs. 9, 10 (1804).

Thecla damon Harr., Hitchc. rep., 590 (1833);—Hewitts., Ill. diurn. Lep., iii: 94, pl. 37, fig. 100 (1867).

Polyommatus damastus God., Encycl. méth., ix: 602, 640, pl. 41, figs. 14, 14 bis (1810).

Thecla damastus Westw.-Hewitts., Gen. diurn. Lep., ii: 486 (1832).

Lycus gryneus Hüb., Verz. schmett., 74 (1816).

Thecla smilacis Boisdu-Lec., Léop. Amér. sept., 107-108, pl. 33, figs. 5-8 (1833);—Morr., Syn. Lep. N. Amer., 98-99 (1862);—Middl.,

Rep. Ins. Ill., vii: 93 (1881);—French, Butt. east. U. S., 268-269 (1886);—Mayn., Butt. N. E., 35, pl. 5, figs. 43, 43a (1886).

Mitoura smilacis Scudd., Syst. rev. Amer. butt., 31 (1872).

Thecla auburniana Harr., Ins. inj. veg., 3d ed., 277-278 (1862);—Morr., Syn. Lep. N. Amer., 101-102 (1862).

Thecla simaethis Herr.-Schneff., Corresp. zool. min. ver. Regen-b., xxiii: 58 (1869).

Thecla castalis Edw., Trans. Amer. ent. soc., iii: 208 (1871).

Figured by Glover, Ill. N. A. Lep., pl. 28, fig. 3; pl. 38, figs. 2, 3; pl. B, fig. 7, ined. (Not Pap. simaethis Drury.)

See her bright robes the butterfly unfold,
Broke from her wintry tomb in prime of May!
What youthful bride can equal her array?
Who can with her for easy pleasure vie?
From mead to mead with gentle wing to stray,
From flower to flower on balmy gales to fly,
Is all she has to do beneath the radiant sky.

THOMSON.—*Castle of Indolence*.

Of such a merry, nimble, stirring spirit,

SHAKESPEARE.—*Love's Labour's Lost*.

Imago (6: 17, 18). Head covered in front with luteo-ochraceous hairs, above with dark brown scales, partially concealed by overarching ochraceous hairs; between the antennae are sometimes found a few green scales; eyes encircled, excepting above and a narrow break beneath, by a rather broad band of snow-white scales, extending upward in front of the antennae and connected just above the tongue by a broad

V-shaped band of similar scales. Basal joint of antennae black; stalk glossy purplish black, interrupted pretty broadly at the base of each joint with white scales, sometimes partially obsolete above on the basal half of the antennae; club glossy blackish brown, the white annuli at the base confluent beneath and extending apically over nearly half of the club; terminal two joints dull orange luteous, the incisures of some of the adjacent joints sometimes faintly tinged with the same and occasionally running in a line down the infero-interior surface of the whole club. Basal and middle joints of palpi covered with long white scales, the extreme base of basal joint and the upper surface of the middle joint with dark brown scales, which are also scattered infrequently among the white scales, especially on the outer surface of the middle joint; upon the under tufted surface of these joints a few blackish and ochraceous hairs arise, extending beyond the white scales; terminal joint blackish brown, tipped with white and often with a broader or narrower band of white scales down the inner edge of the under surface. Tongue luteo-testaceous on basal half, fusco-testaceous beyond.

Thorax covered above with olivaceous brown scales and long hairs, the patagia edged with a few paler scales; beneath with profuse, but not very long, dirty gray hairs, and a few scattered black ones. Femora speckled with white and blackish purple scales, the former greatly predominating on the inside of the front and middle pair, the tuft of the under surface like the hairs of the under surface of the body; tibiae and tarsi blackish purple, annulate with white and with mingled blackish and white—white at the tips of the joints, the mingled colors at the base and middle of the tibiae and the middle of the first tarsal joint; tarsi beneath luteo-fuscos; spines black, claws dark reddish.

Wings above dull blackish brown, the lower portion of the fore wings as far up as the subcostal nervure and excluding the base, and a rather broad band at the outer margin, either brassy ochraceous (♂) or tawny (♀), the color traversed by blackish brown veins; lower inner portion of the hind wings (usually as far as the subcostal nervure, and excluding nearly the basal half of the wing and, at the outer margin, a narrow band, which usually develops, in the interspaces, into blackish lunules seated on the margin, but often separated from it, near the anal angle, by a slender line of white scales) either obscure brassy ochraceous (♂) or tawny (♀), traversed, as in fore wings, by blackish veins; fringe of both wings blackish or brownish fuscous, the imbricate base marked, on the fore wings indistinctly, on the hind wings distinctly, with white, faint merging into bright; tails black, tipped with white, the base with a few tawny scales. Discal spot of fore wings of male 2.5 mm. long, oblong oval, the inner extremity slightly the smaller, about twice as long as broad, dust gray.

Beneath green, flecked with a few ferruginous scales. The portion of the *fore wings* covered by the hind pair pale slate brown, the median interspaces more or less suffused with ferruginous, and a distinct, transverse, snow white stripe, subparallel to the outer border and about as far from it as twice the width of the interspaces at the outer border, transected by pale brown scales along the nervules and bordered on the inner side with ferruginous; it is very nearly straight, usually nearest to the outer border in the upper median interspace and, starting from just below the costal border, reaches the lowest median nervule; here it is broken and crosses the next interspace farther from the outer border, reaching the inner margin by an angular, -shaped, often obsolete streak, bent strongly inward and tending to unite this band with the mesial band of the hind wings; costal border narrowly edged with fusco-ferruginous; outer border, especially on lower half of the wing, frequently edged narrowly with ferruginous, the immediate margin usually furnished with a delicate line of white scales, interrupted at the nervules; fringe pale, obscure fuscous, palest on the lower half of the wing. *Hind wings* with a very tortuous snow white stripe, bordered on the inner side with dark cinnamon, crossing the wing just beyond the middle; starting at about the middle of the outer half of the costal border, it crosses the subcostal interspaces, subparallel to the outer border; is then bent suddenly inward toward a point a little within the centre of the wing, and, having crossed the interspace beyond the

discoidal cell, it bends again, quite as suddenly, toward the outer margin and reaches, on the nervule dividing the median interspace, its greatest proximity to the outer border—from two-thirds to three-fourths the distance from the base to the outer margin of the wing; having crossed the lower median interspace as a strongly bent crescent, opening outward, it is again bent abruptly, crossing the next interspace, as near the base as the band at its origin, as a bent crescent, opening outward, and the last, a little more distant from the base, as a curved streak, opening and directed inward; the band terminates near the tip of the abdomen. Near the base of the wing are two streaks, colored like the extra-mesial band, but with the position of the colors reversed, one above the subcostal nervure and one in the discoidal cell; the first is parallel to the initial portion of the extra-mesial band and is from one-third to one-half the distance from the base of the wing to the band; the second is irregular in position and direction; usually it is bent at right angles, the lower limb nearly obsolete; sometimes it is merely a straight stripe, either parallel to or bent away from the base at an angle with the first streak; it is always situated considerably further from the base than the first and usually approaches the inward curve of the mesial band so as to be separated from it by only the width of an interspace. A very little beyond the outermost point of the extra-mesial band there is a row of four or five small, usually transverse blackish spots, distinct only in the median and submedian interspaces, lying subparallel to the outer border, each spot narrowly annulate with white atoms; in the lower median interspace, a little beyond the spot of this series, there is another similar one, the space between filled with obscure orange; and, similarly situated, next the inner border, is a white spot, often bisected transversely by a black line; the outer margin of the wing is distinctly bordered with white, interrupted at the nervure tips; upon this, as far as the row of spots, often partially enveloping them, and lessening toward the anal angle (where it is often supplanted to a greater or less extent by ferruginous scales) the wing is gray with blackish or ferruginous scales, largely sprinkled with snow white atoms—the latter color often predominating in annuli as broad as the interspaces, giving the appearance of obscure large spots seated on the outer margin; nervure tips on the lower half of the wing bordered with black; extreme anal angle with a minute black spot; basal half of fringe dull ferruginous, middle faint milk white, tip pale brown; tails black, white-tipped, the longer with some ferruginous scales at base; inner edge with brownish red and pale yellowish hairs.

Abdomen dark brown above, at sides with scattered brownish yellow scales, beneath grayish yellow. Male appendages (34:28); alations of upper organ pretty regularly and broadly rounded, furnished with a slight, angular lobe at the upper base of the lateral arms; the inferior edge rather broadly angled; clasps a little sinuous, produced to a needle-like point, the whole as long as the upper organ.

Measurements in millimetres. Length of tongue, 3.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	12.	12.35	12.75	10.6	12.8	14.2
antennae.....	6.	6.5	7.	5.20	6.25	6.75
hind tibiae and tarsi.....		4.25			4.	
fore tibiae and tarsi.....		3.25			2.75	

Described from 20 ♂, 19 ♀. Length of longer tails, 1.5 to 3.2; aver. 2.25.

Varieties. In one specimen, the portion of the extra-mesial band of the secondaries, which crosses the medio-submedian interspace, separates itself entirely from the rest of the band, and forms an independent, longitudinal, slightly curved streak, almost connecting the lower basal streak with the extra-mesial band.

A single specimen from the south differs from all otherwise similar specimens from the north in having the wings above of a uniform brown color, lighted up by no reddish tints, and in having the longer tail of the hind wings 5.5 mm. long, or fully twice the length of the average northern specimens—in all which it agrees with the illustra-

tion given by Boisduval and LeConte. The basal spots on the under surface of the hind wings are also reduced to two small, roundish spots.

A single female from Long Island (Graef) has the upper surface entirely blackish brown with no tawny scales, excepting a very few inconspicuously scattered near the hind margin of the hind wings; the tails are of the usual length, and the extra-mesial band of the under surface of the hind wings is less tortuous than common. Length of fore wing, 13.5 mm.

Secondary sexual peculiarities. The discal stigma of the male is described under the fore wing; the scales (46:23) found in it are remarkable for their large size and breadth, as they are less than two and a half times longer than broad, with scarcely convex sides, and a general quadrangular shape, the basal lobes distinct but not prominent.

Egg (65:4). Prominences granulose, .11 mm. apart, and .049 mm. broad; surface of shell more or less covered with rugosities. Micropyle rosette .22 mm. in diameter, composed of a central circle .00425 mm. in diameter, surrounded by six oval cells, their longer axes directed toward the centre and .025 mm. long, the shorter .017 mm. long; outside of these are angular cells of scarcely larger size, averaging about .034 mm. in greatest length. Color pale bluish green. Height, .32 mm.; breadth, .62 mm.

Caterpillar. *First stage (71:3).* Head pallid yellowish green, slightly infuscated above; ocelli black. Body below yellowish green; sides (at least late in this stage) with a broad, faint, reddish brown stripe, its lower edge next the upper limit of the lateral fold, narrowing anteriorly; and a narrower dorsal band of similar color but not so distinct, merging into the other posteriorly, and, anteriorly, fading out so as to be wholly absent from the thoracic segments. Hairs brown.

Second stage. Head pale greenish luteous, the clypeus pallid and the labrum tinged with pink; ocelli pale, in a black field; mouth parts pale green. Body pale, dull, lemon yellow, most conspicuous on lateral fold, the markings of the preceding stage repeated with slightly deeper colors. Whole body also bristling with numerous and almost equally distributed brown hairs, scarcely longer than the middle segments of the body, coarse and slightly tapering at tip, but equal elsewhere, microscopically spiciferous. Legs and prolegs pale green. Spiracles pallid. Length, 1.75 mm.

Last stage (75:30, 31). Head (79:27) pale green, inclosures brown, clypeus white, labrum testaceous; basal joint of antennae white, rest pale testaceous; other mouth parts pale testaceous; ocelli in a small circle, pale, with a basal black annulus.

Body rich, dark velvety green, of exactly the color of juniper leaves, covered not very profusely with short, brown or brown tipped, whitish pile. The most conspicuous markings are supralateral, broken rows of slightly oblique, white, sublunate dashes on each of the abdominal segments, more or less tinged with green, and generally broadest in front; and similar, but straighter, slenderer and more continuous streaks forming an infrastigmatal band; midway between these, on the posterior edges of the segments, is a line of faint, oblique, greenish white lines, far less conspicuous. All these markings are found also on all the thoracic segments, but the upper two series on the first and second segments are merged into a large, transverse, and somewhat obscure spot, on the first segment sometimes cuneiform and dull orange. There is a slender, dorsal thread of pale green, marked at the inclosures by a dark green dot. Spiracles white. Legs pellucid green, infuscated apically; prolegs, green, the claws black. Length, 15 mm.; breadth, anteriorly, 3.6 mm.; posteriorly 3 mm.

Chrysalis (84:30, 31). Rich wood-brown, the head, thorax and appendages tending to a faint, greenish luteous, the abdomen to ferruginous; after death or eclosion becoming dull yellowish brown, with a decided reddish tinge, heavily marked, especially on the under surface and the whole abdomen, with vermicular blotches of blackish fuscous. In front of the abdomen, above and on the sides, these markings are mostly confined to roundish or transverse blotches, irregularly and variably disposed, but not occupying more than perhaps an eighth of the surface; on the abdomen they are no more regularly but more uniformly distributed, and occupy nearly or quite half

the surface, in a very coarse, irregular reticulation, in which may with difficulty be recognized a central, infralateral series of roundish spots, and a postero-central, suprastigmatal series of similar spots growing somewhat obscure posteriorly; and sometimes a macular, infra-stigmatal stripe: stigmata bright luteous, the lips white. The network of interlacing ridges is concolorous with the ground, the ridges distinct but delicate, low and equal, forming tolerably large cells, the floor of which is minutely punctate, the punctae ovate. The sparse, dark brown pile consists of hairs which are less than a third as long as the abdominal segments, tipped with blackish fuscous, minutely spiciferous, and seated on very inconspicuous papillae. Spiracles testaceous, with white lips. Length, 9 mm.; breadth in middle of thorax, 3.1 mm.; in middle of abdomen, 4.75 mm.; height of thorax, 3 mm.; of abdomen, 4.5 mm.

Distribution (23:7). This butterfly is a member of both the Carolinian and Alleghanian faunas, being found in all the Atlantic states from northern Florida to Massachusetts. We know very little of its western extension as it has been seldom expressly recorded, but as it is found in the south as far west as northwestern Texas and in the north to Dakota (Morrison), it probably everywhere extends to the Great Plains. Worthington says it occurs in Illinois, Saunders records it from Point Pelee in southern Ontario, and Dimmock took it at Cumberland Gap, Kentucky.

In New England it occurs only in the southern portions and seldom in any great abundance. Its most northern known locality is the vicinity of Boston where it has been taken in West Roxbury, Hyde Park and Dorchester "quite abundant" (Faxon), Lynn (Merrill), Quincy (P. S. Sprague), Wyoming (Morrison), Cambridge and Milton (Harris), Blue Hill (F. H. Sprague) and Walpole, Mass. (Guild). It has also been found at Springfield (Emery), Mt. Tom (Dimmock), Holyoke Range (Parker) and Holyoke, Mass. (Stebbins); and at New Britain (Dimmock, Hulbert, Seudder), Guilford (Smyth—Yale Coll. Mus.), Farmington (Norton) and New Haven, Conn. "abundant" (Verrill, Smith, Harger—Mus. Yale Coll.).

Haunts. The butterfly may be found about red cedars and will hardly be found where these do not occur. The under surface of the wings of the butterfly so closely resembles the color of the leaves of the red cedar that when it has once alighted upon this tree one can only discover it by jarring the trunk and startling it again to flight.

Oviposition. The eggs are laid near the tips of the blossoming twigs of red cedar, a large number being found by Mr. Hulbert and myself on these spots, while the less forward twigs were sought in vain for a single egg. They were generally tucked in or near the chinks of the overlapping scales but sometimes with no attempt at concealment.

The female lays with wings erect, first rubbing together the hind wings slowly for a time, then rapidly, immediately after which she hedges about as if to get into a good position, extends and lowers her abdomen, deposits the egg, withdraws the abdomen and then flies away. The sight of the process suggested that perhaps the rubbing of the wings may here be the

mere result of the correlated action of muscles with those working to force the egg downward in the oviduct. The duration of the egg varies, but averages about a week.

Food plant. Boisduval and LeConte, on the authority of Abbot, state that this caterpillar feeds on *Smilax*—hence the name they gave; but in the north it occurs only where *Smilax* does not grow, and it is the universal opinion of those who have sought its haunts that here it feeds only upon red cedar (*Juniperus virginiana* Linn.). It has always been observed in the close vicinity of this tree, and independent notes to the same effect have been contributed by Messrs. Merrill, Verrill and Faxon. Mr. Faxon has for many years obtained specimens flying about an isolated cedar in the vicinity of Boston, and within a year or two Mr. E. M. Hulbert and I obtained eggs in abundance from this tree, where indeed we saw the butterfly ovipositing and on which we have since raised it.

Habits of the caterpillar. The color of the caterpillar is so exactly of the same rich green as the plant on which it feeds that it is admirably protected. It feeds on the tips of the sprigs, covering the head with the first thoracic segment as with a cowl while feeding, so that one would not know it was at work but for the regular muscular movements of the body. The excrement is of remarkably large size, the pellets of the full grown larva measuring a millimetre in diameter. It takes the caterpillar a little more than five weeks to grow to maturity.

Life history. This insect is double brooded, the earliest butterflies appearing about the first of May—sometimes not until the 7th or 10th; they become abundant by the 15th or 20th and continue on the wing throughout June. The eggs, which they begin to lay about the middle of May, hatch in about a week, and the caterpillars take five or six weeks for their growth, so that they begin to go into chrysalis toward the end of June; some of these chrysalids, in the opinion of Mr. Hulbert who has raised them in Connecticut, remain unhatched until the following spring; others hatch in about a fortnight, and the second brood appears about the 20th of July and continues into August, much less abundant than the first. The chrysalids from the eggs laid by this brood pass the winter.

In the south, Abbot bred larvae which changed to chrysalis and emerged in thirteen days in April, so that the butterfly there is probably triple brooded or polygoneutic.

Habits of the butterfly. Dr. Harris observed that this pretty butterfly was fond of the flowers of mouse ear, *Antennaria plantaginifolia*, in spring, and in August of those of the spearmint (*Mentha*). Professor Parker also found it early in August on flowers of the mountain mint, *Pycnanthemum incanum* and Abbot says the butterfly "frequents blackberry blossoms in the neighborhood of Savannah." Sumac (*Rhus*) has also a great attraction for it. The butterfly is extremely active and when

playing with its mates or pursuing the female, may generally be seen around the tops of cedars, of a height of about twenty feet. Here each takes up position ready to have a scrimmage with the first one that ventures on the wing, and then three or four may often be seen whirling in circles about the tree-spires with wonderful rapidity, a play which ceases almost as suddenly as it begins.

Postures. When walking, the body is inclined at an angle of about 20° , the tip trailing and the inner border of the hind wings parallel with the surface; the wings are elevated, closely compressed and the hind pair scarcely at all concealed by the fore wings; the antennae are spread at an angle of 65° - 70° and viewed from above appear straight, but they curve a little downward and the clubs a little upward so as in general to droop a little below the plane of the body.

When at rest, the wings are held in the same position, but the antennae diverge from 85° to 95° , and while retaining the same or a slightly less curve, are in general parallel with the body or even raised a very little above it; the wings are often inclined from the vertical, sometimes as much as 45° ; on alighting, the butterfly, of whichever sex, often rubs the hind wings together. The action of the female in laying is described above.

When at complete rest, the fore wings are dropped a little, although never farther than would bring the costal edge of the hind wings to the lowest median nervule of the fore wings; the antennae then diverge as much as 95° and are raised above the plane of the body at an angle of at least 15° .

Desiderata. The inland distribution of this insect, its food in the larval state in the south, the history of the second brood, the proportion of early chrysalids which hibernate, and the possible parasites of the insect are desirable subjects of investigation.

LIST OF ILLUSTRATIONS.—MITURA DAMON.

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THECLA FABRICIUS.

Thecla Fabr., Ill. Mag., vi: 286 (1807). Type.—Pop. spinii Wien, Vers.

Meng Sommervogel schöner Art
 Eit untarn Bode wohl verwahrt;
 Es het kel Chummer und kel Ching,
 Und wartet uf si Ostertag
 Und ganz au lang, er chumt emol
 Und sidler schloft und 's isch em wohl.

HEBEL.—Der Winter.

Imago (58:4). Head small, densely clothed with scales, and above with short hairs; on the front the hairs are exceedingly short and sparsely scattered. Front not at all prominent, almost flat, barely surpassing the front of the eyes, slightly sunken down the middle above, below very slightly tumid; twice as high as broad, or a very little less than that, from two-thirds to three-quarters the width of the eyes as seen in front; upper border raised to a very slight ridge in the middle third, the corners considerably hollowed in front of the eyes, lower border strongly arched. Vertex a very little tumid in the middle, with a slight sign of a transverse ridge behind the middle, on either side forming a swollen buttress to the base of the antenna, and separated from the occiput by a broad, transverse furrow varying in depth, but always conspicuous. Eyes rather large and full, very sparsely and very briefly pilose, excepting on the upper third. Antennae inserted with the hinder edge of their bases just in front of the middle of the summit and separated from each other by three-quarters the width of the antennal pit; about half as long again as the abdomen, consisting of from twenty-eight to thirty joints, of which from eleven to fourteen form the cylindrical club; usually the latter is very gradually thickened, always but slightly, being scarcely twice as wide as the stalk; it is, however, fully eight times longer than broad, and the tip is very bluntly rounded, four or five joints entering into the diminution of size, but only the last two to any considerable extent. Palpi rather slender, fully half as long again as the eyes, the terminal joint about three-quarters the length of the penultimate and clothed with recumbent scales, the other heavily clothed, especially beneath, with long scales, closely compressed in a vertical plane.

Patagia exceedingly long and slender, arched and very slightly convex, three or four times longer than broad, roundly shouldered on the inner margin near the base, the basal half, or a very little more than the basal half, narrowing regularly but slowly, the apical half, which is not more than half as broad as the widest portion, nearly or quite equal, terminating in a broadly rounded apex; the inner border throughout nearly or quite straight.

Fore wings (39:11) about half as long again as broad, the costal border pretty strongly convex and almost bent on the basal fourth, the middle half straight, the apical fourth very gently curved backward, the outer angle more than a right angle, scarcely rounded. Outer margin very gently and pretty regularly curved, apparently slightly more so in the ♀ than in the ♂, having a general direction at an angle of about 60° with the middle of the costal margin; the inner margin straight, the outer angle rounded off. Costal nervure terminating just beyond the tip of the cell; subcostal nervure with three superior branches; the first arising at or a little beyond the middle of the outer four-fifths of the cell; second midway or a little further between this and the apex of the cell (♀), or less than one-third the distance to the same (♂); the third at or just beyond the tip of the cell (♀), or midway between the origin of the first and the tip of the cell (♂); the main stem beyond the origin of the second branch either straight (♀), or strongly arcuate, convexly downward, to a little beyond the tip of the cell and then straight (♂); cross vein closing the cell transverse, very feebly developed excepting next the main subcostal nervure. *Thecla ontario*, however, differs so much from the others that it is separately described under the species.

Hind wings with the costal margin rather full and convex, a little straightened in the middle, curving backward roundly at the tip, joining the curve of the outer margin, which is a little full at the middle subcostal nervule, especially in the ♂, but beyond that pretty regularly and broadly rounded, more or less obscurely angulated at the lower median nervule, where there is always a long and slender thread-like tail, longer than the width of an interspace at its base; there is also a secondary very slight projection at the tip of the middle median nervule; the inner margin is rather broadly convex, more strongly next the base, and just before the tip angularly, though but little, emarginate. Submedian nervure terminating on the outer border, just by the anal angle; internal nervure terminating beyond the middle of the inner margin.

Androconia slender, sublanceolate, about four times as long as broad, subequal but tapering slightly on apical half, the apex broadly rounded, the stalk very long.

Fore tibiae about three-quarters the length of the hind tibiae, the fore legs similarly developed in the two sexes, excepting at the terminal tarsal joint, and with the same exception and the nakedness of the tibial spurs, resembling the other legs very closely; fore tarsi but little shorter than the tibiae, the last tarsal joint either developed as in the other legs (♀); or very small, similar to the preceding joint, bearing at its unenlarged extremity simply a pair of slightly curved spines, differing in no respect from the others behind and having its upper surface thickly covered with extremely short hairs (♂). All the femora of the male (and male only) heavily fringed beneath with long hairs. Middle tibiae more than six-sevenths the length of the hind pair, armed beneath with a very few short and slender spines, and at tip with rather long, tapering, scaly spurs. First joint of tarsi more than equalling the rest taken together, the others nearly equal, all furnished beneath on either side with a clustered mass or row of small, not very slender, crowded spines, a single one on either side of the apex of each joint being longer, spur-like. Claws small, strongly compressed, tapering to a fine point, strongly curved or bent before the middle, with a small, basal, triangular, laminate tooth beneath; paronychial simple, slender, nearly equal, curving a little in the opposite direction to the hook, than which it is a little shorter; pulvillus very minute, thrust forward, nearly circular.

Male abdominal appendages: upper organ with such broad alations as to leave in the middle behind a broad, deep notch, the bottom of which is squarely cut; the alations tumid, well rounded, of about equal length and breadth; lateral arms very long, slender, tapering, finely pointed, strongly recurved and wholly concealed next the inner surface of the alations; clasp about as long as the upper organ, straight and rather slender, a little gibbous on the basal half, beyond tapering, but very bluntly pointed.

Egg. Depressed echinoid-shaped, as broad at base as at summit, a little depressed and infundibuliform at the middle of the summit, covered everywhere with greatly and abruptly elevated prominences, connected with all about them by heavy well-defined ridges, scarcely disposed in rows, leaving between the ridges deep hollows with abrupt sides, above becoming smaller and confused, the openings between the ridges assuming more the form of pits on an otherwise uniform surface. Micropyle sunken in a not very deep pit, obscure, consisting of a few rather large, oval cells around a minute, central, circular cell, and surrounded by a very few roundish cells of about the same size, their walls faint, but not very delicate.

Caterpillar at birth. Body of nearly equal diameter throughout. The last compound segment tapering and rounded at the tip, flattened on the dorsal area up to the laterodorsal line; below this sloping to the somewhat laterally produced infrastigmatal margin. Laterodorsal series of hairs consisting, upon the abdomen, of larger, centrally situated, curving hairs, about as long as two segments, and outside and a little posterior to them similar, but shorter and more recumbent, backward directed hairs, one of each to a segment in each row. The hairs below the spiracles consist of three on each side, on each segment, one very long, central one, and two shorter, anteriorly placed, the upper the longer. Midway between the laterodorsal,

hair-bearing papillae and the spiracles, but nearer the former, is a series of round smooth, hemispherical lenticles situated in the middle of the anterior half of all the segments, both thoracic and abdominal, excepting the large first thoracic segment. The laterodorsal and substigmatal series of hair-bearing papillae are also repeated on the third thoracic segment, and to a certain extent on the others, with certain changes of position and the addition of others. No laterostigmatal series of hair-bearing papillae. On the last compound abdominal segment the hairless lenticles of the lateral row forms one of a series of five on either side: three larger, equidistant ones placed in an open curve diverging posteriorly from the opposite set, and two smaller ones posterior to these, one behind and a little outside the other in the laterodorsal region.

Mature caterpillar. Head small, smooth, rather appressed in front, rounded, a few long hairs about the ocelli; broadest above the middle, well rounded below; tri-angle half as high again as broad, reaching about two-thirds way up the front. Second joint of antennae broader than long, cylindrical but tapering, third as long as the second, but only half as broad, cylindrical, barely tapering; fourth a minute wartlet by the side of a long, slightly curved hair. Ocelli six in number, three above nearly touching each other in a slightly curved row, its convexity forward and upward, in front three in a straight row along the base of the antennae, the upper being the anterior one of the previously mentioned row, situated at a distance from each other less than the diameter of one of them; and a sixth behind the lowest of the last row, so far as to form a right angle with it and the uppermost of all the ocelli; all of equal size, the sixth flat, the others convex. Labrum pretty large, fully twice as broad as long, the front roundly excised to a moderate depth in the middle, either lateral half well rounded in front. Mandibles short and quite broad, the edge slightly wrinkled and sinuous, scarcely denticulate. Maxillary palpi with the basal joint bearing an inner and an outer palp, the basal joint of the outer cylindrical, broader than long; second cylindrical, twice as broad as long, and two-thirds as stout as the preceding, the apical joint similar to it, but only half as broad and tapering slightly, the inner palp consisting of two joints similar to the apical two of its neighbor, but a little smaller. Spinneret small and linear. Labial palpi apparently consisting of a single cylindrical, very slender joint.

Body marked with longitudinal and oblique stripes and bands, pretty regularly arched longitudinally, but elevated more anteriorly than posteriorly, and sloping almost uniformly over the whole abdomen, but more rapidly on the last two segments; viewed from above elliptical, the anterior border broadly rounded, broadest on the middle of the thoracic segments, tapering posteriorly very gently to the seventh abdominal segment; behind narrowing to a more sharply rounded tip; dorsal area narrow, flat or slightly sulcate; sides pretty high, tectiform; substigmatal fold rather prominent, uniform; segments not at all arched or prominent. Skin delicately shagreened, the whole upper surface covered uniformly and somewhat frequently with minute warts, emitting short, erect, inconspicuous hairs; upon the summit and anterior portion of the first thoracic segment they are twice or thrice as long and stouter, and there is also a series of similar hairs upon the laterodorsal ridge and the substigmatal fold, a good many hairs to each segment. The short hairs are of uniform thickness throughout, smooth and round tipped; the long ones taper very slightly, are not delicately pointed, and are uniformly, distantly, and very delicately spiculiferous. Spiracles very small, almost round, or a very little ovate. Legs very small, tapering, the last joint very slender, the claw minute, delicate, curving considerably and regularly. Prolegs very short, rather stout, each furnished at tip with a double pad and each pad with a double crescentic row of rather slender claws.

Chrysalis. Viewed from above the outline of the body is a little more than twice as long as broad, composed of two longitudinally contiguous, broad and short ovals, one about five-eighths of the whole, formed by the abdomen, and one by the parts in front; the latter is considerably shorter and but slightly narrower than the former, scarcely narrowing behind at its junction with the abdomen, narrowing somewhat

and well arched in front, the prominence of the head scarcely causing any lack of regularity in the curve, the basal wing tubercle scarcely perceptible; the abdomen quite regular and equal in its curve, the posterior end being pretty broadly rounded. Viewed laterally the division between thorax and abdomen is marked by only a small, rounded hollowing; the thorax is most prominent just behind the middle of the mesothorax, and curves forward with a full and rather rapid, pretty regular, downward arch, the same curve continued backward posteriorly with perfect regularity; the abdomen is roundly and regularly arched, highest, and slightly higher than the thorax, at the third and fourth segments, the posterior end of the body sloping about as rapidly though generally a little less than the anterior, the apical half of the ninth abdominal segment being perpendicular. Transversely the middle of the thorax is well arched, but considerably and rather broadly hollowed in the middle of each of sides, the summit well rounded; transversely the middle of the abdomen is very broadly and regularly rounded, forming a scarcely depressed semicircle. Three-fifths of the tongue exposed, the inner sides of the legs having the tongue interposed between them. Basal wing prominences consisting of exceedingly slight, transverse, oblique, low ridges. Posterior border of the wings straight. Whole body covered with an interlacing, delicate network of raised lines, distinct under a lens, their points of intersection generally raised a little and bearing a little wart; other independent warts in the cells, broader than high, give rise to spiculiferous hairs, generally rather short, sometimes very short. Hooklets short and very slender, the stem equal, curved somewhat at the tip, bearing a sudden lenticular expansion, which is bent downward almost upon the stem, the lateral portions a little produced downward, the expansion three times as broad as the stem.

This group of tailed Theclidi occurs in the north temperate zone of both hemispheres, in each of which it extends across the entire continent. It is one of the most abundantly represented genera of our fauna; no less than five species occur within the limits of New England; all of them extend some distance to the west, most of them a considerable distance to the south and nearly or quite all a short distance to the north; only one or two are at all common and one is exceedingly rare.

The butterflies of this group are about the medium size for Theclidi and of very elegant form; their hind wings are furnished with two thread-like tails of unequal length, their upper surface is uniform blackish brown, occasionally ornamented at the base of the tails with a brilliant orange spot; beneath they are of various shades of gray or light brown with double or triple, more or less complete, common, marginal rows of small, pale spots or streaks, and on the hind wings a series of colored crescents, which become quite large and conspicuous beside the anal angle. The fore wings of the male are furnished with an obovate discal spot.

The butterflies are all single brooded, and appear in the New England region about the beginning of July and lay their eggs about the end of the month. The eggs in some cases do not hatch until spring, or if they do, the caterpillar probably hibernates without feeding, and the insect remains in the chrysalis state—generally in June—from eight to seventeen days. The caterpillars feed almost exclusively upon the leaves of trees or large woody shrubs.

The transformations of all but one of our species have been studied.

The eggs are of a depressed echinoid shape, covered with strong and rather coarse prominences and ridges, arranged with a certain degree of regularity.

The caterpillars are somewhat elliptic as viewed from above, pretty regularly arched, but highest in front; they are generally green with a darker dorsal stripe and a lateral series of darker, slender, oblique stripes or streaks.

The chrysalids are about twice as long as broad, well rounded and arched, the surface covered with a delicate lace-work of raised lines; they are usually dark, dull brown.

EXCURSUS XXXI.—SEXUAL DIVERSITY IN LEGS. WINGS
AND SCALE ARRANGEMENT.

Eftsoones that Damzell, by her heavenly might,
She turn'd into a winged Butterflie,
In the wide aire to make her wandring flight;
And all those flowres, with which so plentifullie
Her lap she filled had, that bred her spight,
She placed in her wings, for memorie
Of her pretended crime, though crime none were:
Since which that Flie them in her wings doth beare.
SPENSER.—*Muioptomos*.

IN a previous excursus on antigeny* we called attention to some of the differences between the sexes as seen at first glance in the color or color pattern of the wings. Antigeny, however, does not confine itself to such superficial appearances. It is seen quite as much in the more essential features of the structure, in the wings, the legs, and occasionally even in the antennae.

Sometimes it affects the contour of the wings. Indeed, it is a very common thing to see such differences as appear in *Chlorippe*, illustrated on pl. 16, fig. 7, where, besides minor differences, the hind wings of the female are full and rounded, while those of the male are angulate, the outer margin being nearly straight. The hind wings of our species of *Pieris* also differ considerably, those of the male being more prominent at the extremity of the subcostal nervules while those of the female are more regularly rounded. But the most conspicuous case among our own butterflies is in *Strymon titus*, where the fore wings of the male have a pointed tip, and the hind wings have the inner angle sharply defined; while in the female both the tip of the fore wings and the inner angle of the hind wings are broadly rounded.

So, too, sexual dimorphism may affect the direction of the veins of the wings; usually the difference between the sexes is slight and concerns the point of origin of one or two of the upper branches of the subcostal vein

* See p. 531.

of the front wings; but occasionally it is very marked, as in many of the hair streaks, where the branches of the subcostal vein near the end of the cell are thrown far out of place to accommodate a patch of peculiar crowded scales. This patch itself, moreover, is a feature of the males alone, and occurs in many hair streaks where the position of the vein is not altered.

One of the most curious patches of this kind is found in the males of certain yellow butterflies, of the genus *Eurymus*, although wholly absent from others intimately allied to them; it is a little patch of lustreless scales which occurs at that part of the base of the hind wings which is always covered by the front wings, so that it is quite concealed from sight.

Patches of a different nature also mark the male sex; thus next the middle of the lower median vein of the hind wings of *Anosia plexippus* and in some of its allies, we have a thickening and inversion of the membrane, forming a little pocket and conspicuous from its covering of black scales.

In certain swallow tails, as in our *Laertias philenor*, the inner border of the hind wings of the male is folded back upon itself, concealing some pure white floss-like scales and hairs, which are apparently exposed at the will of the creature, when it is moving forward in flight.

Then, again, there is much variety of male adornment in special modifications of hairs or scales upon the wings; the patch of the hair streaks, just mentioned, is one instance of this; another example is found among the fritillaries in a row of long, fulvous, partially erect hairs along the upper edge of the cell of the hind wings; this is accompanied by a curious apparent thickening of the veins in the middle of the fore wing, due altogether to the presence of a multitude of small and densely clustered black scales crowded against the veins at this point. A faint oblique patch of minute and crowded lustreless scales, accompanied by long silky hairs, is often seen crossing the wings of some of the satyrs or meadow-browns; and if we were to go for our examples outside the range of our own species, these examples might be multiplied indefinitely.

Sexual dimorphism shows itself in the legs in the proportional length of the different pairs in the two sexes, in the special development of certain joints, in the appendages, and in the clothing. It appears remarkably in the appendages of the two higher families of butterflies, *Nymphalidae* and *Lycaenidae*, and especially in the latter family, where the terminal appendages of the fore legs are nearly or quite lost in the males, and are as conspicuous as on the other legs in the female. I have not discovered that the differences in the length of the leg-joints follow any general law, although there are few of our butterflies whose sexes do not vary in this particular; this form of antigeny is also most conspicuous in the *Lycaenidae*. The males of certain *Chrysophanidi* (*Chrysophanus*, *Epidemia*, *Heodes*,

Feniseca) also present another curious feature in a tumid swelling of the basal joint of the middle and hind tarsi. Finally, the fore legs of the males of *Nymphalidae* are frequently furnished with a spreading brush of hairs; or, in other butterflies, the thighs and shanks of the middle and hind legs are supplied with curious pencils or fringes of stiff hair, which appear to have the same significance as similar adornments in higher animals.

There are still further ways in which this form of antigeny could be illustrated from the members of the lowest family, but these are so interesting from several points of view, and so universal in the family that we will reserve them for separate treatment.

* * For references, see the bibliography on p. 535, at the end of Excursus XVI.

Table of the species of Thecla, based on the egg.

Erect filaments at cell angles very long and slender, tapering to a point.....	<i>llparops</i> .
Erect filaments comparatively short, thick and blunt.	
Filaments apically truncate.	
Filaments closely crowded, stout, as broad as height above cell walls.....	<i>calanus</i> .
Filaments rather distant, slender, higher than broad, sometimes twice as high as broad.....	<i>acadica</i> .
Filaments apically rounded.....	<i>edwardsii</i> .
	(Ontario unknown).

Material is not at hand for a satisfactory table based on the caterpillar at birth.

Table of species, based on the mature caterpillar.

Head black.....	<i>edwardsii</i> .
Head green or pale greenish brown.	
Head with a transverse black belt across whole lower part of face.....	<i>llparops</i> .
Head at most only infuscated below or with a black stripe confined to the base of the frontal triangle.	
Body nearly equal, tapering only on the last three or four segments, so that the hinder end is moderately broad.....	<i>calanus</i> .
Body tapering considerably from in front of the middle backward, so that the hinder end is very slender.....	<i>acadica</i> .
	(Ontario unknown).

Table of species, based on the chrysalis.

Body covered with hairs half as long as one of the abdominal segments.....	<i>llparops</i> .
Hairs of body hardly if any more than one-fourth as long as one of the abdominal segments.	
Tracery of raised lines on body no higher at the intersection of the cells than elsewhere....	<i>calanus</i> .
Tracery of raised lines with distinct though minute wart-like elevations at the intersection of the cells.	
Cells of tracery small; hairs very short, their spicules obscure.....	<i>edwardsii</i> .
Cells of tracery large; hairs moderately long, their spicules distinct.....	<i>acadica</i> .
	(Ontario unknown.)

Table of species, based on the imago.

Darker colors of the band crossing middle of outer half of under surface of fore wing edged on the exterior, but not on interior, side with white; upper veinlet closing the cell bent strongly, the lower limb enormously elongated.....**ontario**.
 These same darker colors edged on both sides with white; upper veinlet closing cell straight, no longer than the lower.

These same colors forming quadrate spots, generally edged only with straight white lines on exterior and interior sides.

The white edging forming a broken line by being considerably shifted in position on either side of the median area.....**liparops**.

The white edging forming a continuous or crenulate line.....**calanus**.

These colors forming circular spots, generally completely encircled with white.

Ground color of under surface slate brown.....**edwardsii**.

Ground color of under surface pearl gray.....**acadica**.

THECLA ONTARIO—The northern hair streak.

[The northern hair streak (Scudder); Ontario streaked butterfly Maynard].

Thecla ontario Edw., Trans. Amer. ent. U. S., 265-266 (1886);—Mayn., Butt. N. Engl. soc., ii: 200-210 (1868); Butt. N. Amer., i, Thecla ii, figs. 1, 2 (1869);—French, Butt. East. 31-32, not the plate (1886).

And darted up and down the butterfly.

That seem'd a living blossom of the air.

BRYANT.

... I'll lead you about a round.

Through bog, through bush, through brake, through brier.

SHAKESPEARE.—*A Midsummer-Night's Dream*.

Imago (6:15). Head blackish, the eyes encircled, excepting next antennae and the usual space in its vicinity, with snow white scales, narrowly interrupted beneath, connected by a similar transverse band just above the tongue; a narrow longitudinal stripe of long, mixed white and brownish hairs on the vertex, connected by a similar but slighter line just in front of the antennae; basal antennal joint edged behind with white; antennae purplish black, annulated with white at the base of the joints of the stalk, narrowly above, broadly beneath, forming by their confluence at the base of the club, a pretty large, white patch, with a few scattered blackish scales; club velvety black above, slightly obscured with hoary beneath, the terminal two joints orange. Basal and middle joints of palpi white within and without; the upper outer apex of the basal and the upper outer margin of the middle joint blackish brown; terminal joint blackish brown, the apex and extreme base white and a few white scales beneath. Tongue luteous at base, fuscous beyond.

Thorax covered above with dark mouse brown hairs, the prothoracic lobes with blackish brown and the front of the thorax with greenish and bluish gray hairs; beneath, with pale bluish hoary and on the pronotum with grayish hoary hairs. Femora covered with nacreous scales, flecked with dark brownish scales, especially along the lower, inner border, the lower edge well tufted with grayish pearly and dark brown hairs, the former in excess; tibiae white, flecked with dark brown scales, which especially collect along the median line of the upper surface, which is broken subapically and terminates before the apex; tarsi black, broadly annulated at the apex of each joint, and at the middle of the first, with white; under surface fusco-luteous; spines testaceous, black tipped; claws ferruginous, darker apically.

Wings above lustrous blackish brown with a very slight ferruginous reflection, the veins very slightly, the scales surrounding the discal spot of fore wings in the male decidedly, black; outer edge of all the wings black, preceded, in the lower median interspace of the hind wings and below that, by a slender line of white scales; in the

same interspace, and, usually, to a lesser extent. In the succeeding interspaces, and also in the upper median interspace, there is an orange lunule, seated, at least in the lower median interspace, upon a small blackish spot. Basal half of fringe fuscous; apical half in the fore wings and in the subcostal and median field of the hind wings grayish pearly; beyond this fuscous or nacreofuscous, with a pale median line; tails black, tipped, and the inner edge of the longest one bordered, with white; inner field of hind wings obscured by grayish hairs. In the male the origin of the second superior subcostal nervule is scarcely removed beyond the first and is midway between it and the third, the last being scarcely a fourth way from the origin of the first to the tip of the cell; beyond the origin of the third the main vein turns abruptly downward nearly at right angles a fifth way across the cell, and then as abruptly resumes a course parallel to the last superior branch. The upper half of the vein closing the cell is here most remarkable, being not only distinct throughout the whole of its upper half but bent at right angles, one branch continuous with the deflection of the main stem, the other, excepting a slight twist at the union, with that of the inferior branch; below, the inferior branch is connected with the median by a feeble vein which strikes the median normally beyond its last divarication, but the inferior branch opposite the twist which unites it with its bent cross vein, normally of course but apparently quite out of place. In this peculiarity of venation it is quite unique among Theclae.

Discal dash of fore wings of male 2.5 mm. long, obovate, the ends well rounded, slightly more than twice as long as broad, grayish slaty black in color, conspicuous from its edging of black scales. The outer margin of the hind wings above the longer tail straight, the latter about as long as the width of an interspace, the shorter tail almost obsolete.

Beneath uniform slate brown, lustrous by reflection. *Fore wings* with a slender, interruptedly straight, scarcely curved, transverse, silvery white stripe, bordered interiorly with blackish fuscous, starting from just within the costal border at about the middle of its apical three-fifths and terminating at the submedian nervure, distant from the outer border by less than twice the width of an interspace; beyond this is a transverse series of continuous, moderately broad, submarginal stripes of obscure fuscous, parallel to the margin, becoming obsolete near the costal margin, bordered most inconspicuously on the inner side with a few white scales; costal edge fulvous nearly to the extremity. *Hind wings* with an extra-mesial stripe similar to that of the fore wings, but more interrupted and, in the lower part of its course, variable in direction; starting from the costal border at about the middle of its apical three-fifths, it has, up to the lower median nervule, a general direction toward the tip of the submedian nervure, but an outward curve in the subcosto-median interspace; in the medio-submedian interspace it forms a Λ , the limbs placed at an angle of about 65° to each other; and as it terminates in the last interspace by a long, slightly curving streak whose general direction is parallel to the upper half of the Λ , the portion of the stripe contained in the last three interspaces forms a very distinct *W*; a distantly submarginal series of blackish lunules follows this stripe, growing successively more important away from the costal border and arranged only in a slight degree subparallel to the hind margin; the lunules are edged interiorly with pale bluish scales, most conspicuous next the inner margin, and are followed exteriorly, especially in the median interspaces and below them, by orange lunules, seated, especially in the lower median and lowermost interspaces, upon blackish spots; in the latter, separated from them, next the inner margin, by a minute snow white spot; the medio-submedian interspace is mostly filled with a large, blackish field, profusely flecked with caerulean scales; outer border marked by a blackish line, preceded by a pale line, brightening on the lower portion into white; fringe and tails as on the upper surface.

Abdomen above blackish brown, on the sides paler brown, beneath grayish hoary. Appendages of the male (34:15) with the alations of the upper organ broadly, deeply, and roundly emarginate above, the lateral arms exceptionally long and slender, suddenly tapering near the tip; claspers tapering throughout with considerable regularity, but with slightly less rapidity beyond the gibbous base, the apex very finely pointed.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	13.75		14.25			
antennae.....			8.			
hind tibiae and tarsi..			4.4			
fore tibiae and tarsi..			3.6			

Described from 2 ♂, 1 ♀. Longest tails varying from 1.25 to 3.65 mm. in length.

Secondary sexual peculiarities. For the discal stigma of the male see the description of the fore wing; the scales from the stigma (46: 19) differ from those of all the others in being much more gradually tapering at the base than at the tip, so as not to be lobed at all, and to have the sides broadly curved throughout; it is also slenderer, being nearly four times as long as broad, with a well rounded tip like that of *T. edwardsii*.

This rarest of our *Theclae* is evidently a member of the Alleghanian fauna (23: 8); it has been found, however, in very few localities:—near London, Ontario (Read), Amherst (Merrill) and Waltham, Mass. (Thaxter) and Plantsville, Conn. (Shepard, Yale Coll. Mus.). Mr. Read captured a male in July, Mr. Thaxter his on sumac "in the middle of the berry season," and these are the only recorded dates. Doubtless like the other species it is single brooded and to be looked for in July. No other butterfly confined to our fauna is so little known.

LIST OF ILLUSTRATIONS.—THECLA ONTARIO.

<i>General.</i>		from Edwards's figures in his <i>Butterflies of North America</i> , vol. I.
Pl. 23, fig. 8. Distribution in North America.		34: 15. Male abdominal appendages.
<i>Imago.</i>		46: 19. Androconium.
Pl. 6, fig. 15. Male, both surfaces. Copied		

THECLA LIPAROPS. The striped hair streak.

[The Ogeechee brown hair streak butterfly (Abbot); streaked *Thecla* (Harris); white striped hair streak (Scudder); white bordered streaked butterfly (Maynard).]

- Thecla liparops* LeC., Boisd-LeC. *Lép.* Amér. sept., 99-100, pl. 31, figs. 1-4 (1833);—Morr., *Syn. Lep. N. Amer.*, 96-97 (1862);—Scudd., *Bull. Buff. soc. nat. sc.*, iii: 111 (1876).
- Thecla strigosa* Harr., *Ins. Inj. veg.*, 3d ed. 276 (1862);—Morr., *Syn. Lep. N. Amer.*, 101 (1862);—Edw., *Butt. N. Amer.*, I, *Thecla* II, figs. 3-6 (1869); *Syn. N. A. Butt.*, 51-52 (1872);—Saund., *Can. ent.*, 1: 99-100 (1869); *Ins. Inj. fruit.*, 176-177, fig. 187 (1883);—Pack., *Guide ins.* 267-268 (1869);—French, *Rep. Ill. ins.*, vii: 157-158 (1878); *Butt. east. U. S.*, 266-268, fig. 74 (1886);—Middl., *Rep. Ill. ins.*, x: 92-93 (1881);—Fern., *Butt. Me.*, 79-80 (1884);—Mayn., *Butt. N. E.*, 32-33, pl. 6, figs. 38, 38a (1889).
- Pupilio*—Abb., *Draw. ins. Ga., Brit.*, Mus. vi: 51, figs. 165-167 (ca. 1860).
- Figured also by Abbot, *Draw. ins. Ga.*, Oemler coll., *Bost. soc. nat. hist.* 22;—Glover, *Ill. N. A. Lep.*, pl. B, fig. 4; pl. E, fig. 17; pl. G, fig. 2; pl. K, fig. 3, ined.

... dead July, whose children the sweetpeas
Are sipped by butterflies with wings asfir.

TODHUNTER.—*In August*

O, let me, true in love, but truly write,

SHAKESPEARE.—*Sonnet*.

Imago (6: 11). Head black, with intermingled brown scales, especially in the middle of the front; vertex with a short, longitudinal, median stripe of white hairs; eyes encircled with snow white scales, extending from the lower anterior edge of the antennae down the front and around nearly to the antennae again, interrupted narrowly

at the base of the palpi with brown scales; a broad, straight band just above the tongue, connecting these two. Antennae bronze black, the joints of the stalk rather broadly but irregularly annulated at the base with white; club velvety black above, beneath snow white at base, beyond obscure blackish brown, sometimes faintly suffused with orange, the terminal four or five joints entirely orange both above and below. Palpi white, the outside of the extreme tip of the basal joint, the upper surface, the outside of the upper outer border (and sometimes the whole upper border), the inside of the upper inner border and a few hairs of the outer fringe of middle joint black or blackish brown; apical joint blackish brown, the apex and base and a few scales along the lower edge white. Tongue pale luteous on basal third, beyond infuscated; papillae (61:44) testaceous, equal, bluntly rounded at tip, with a slender, acicular, apical spine half as long as the width of the papilla.

Thorax above covered in front with dark brown, elsewhere with mouse brown or sometimes grayish brown hairs, those of the patagia slightly tinged with greenish gray, the anterior scales of prothoracic lobes often pale gray; beneath covered with white hairs and scales, the latter mingled with grayish scales on the sides; femora white with white hairs beneath, the sides speckled somewhat with blackish brown; tibiae white, with a subapical, blackish brown, exterior patch and a similar obscure one in the middle of the basal two-thirds; a few dark scales are also scattered irregularly; tarsi black, the apices of all the joints and the sides and a median annulation of the basal joint white; beneath luteous; spines black; claws luteo-fulvous.

Wings above uniform blackish brown, the hind wings softer, all the wings, but especially the front pair, with a very faint olivaceous reflection; edged narrowly along the outer border with blackish, which is itself margined interiorly with a line of snow white scales on the lowest median and innermost interspaces of the hind wings; the hind wings occasionally with an obscure, submarginal orange spot in the lower median interspace, sometimes followed in the succeeding interspaces by a few orange scales and usually with the greater distinctness just above the anal angle; these orange markings are always seated in the lower median and medio-submedian interspaces upon an obscure blackish spot which is present even when the orange markings are obsolete; fringe grayish brown on the fore wings and the upper part of the hind pair, merging into blackish brown toward the anal angle, and in this darker portion enlivened by a line of white, running through the middle; at the extreme anal angle wholly white in a narrow space; inner edge of secondaries with long, grayish brown hairs, just above the orange spot in a minute space, white; tails black, tipped, and longer one edged on the inner side, with white. Discal stigma of fore wings of male oblong obovate, 1.8 mm. long, about twice as long as broad, at either extremity running in projecting teeth along the nervures, obscure, dark grayish fuscous. Superior subcostal nervules of fore wings of female arising nearer the apex of the cell than in the other species; the main stem of same not slightly flexed beyond the last superior branch as in the other species, but forming a very considerable angle with its previous course. Outer margin of hind wings pretty regularly curved, below the longer tail a little excised; the longer tail nearly half as long again as the width of an interspace, the shorter one nearly as long as the width of an interspace.

Beneath dark brown, fresh specimens, especially of the female, with a very delicate, rufo-purplish sheen by reflection. *Fore wings* having the extremity of the cell marked by a large, very broad, quadrate, slightly darker spot—in fresh specimens often tinged with rufous—generally increasing in depth almost to black toward the outer and inner edges and then lined with a row of bluish white scales; the spot is nearly or quite as broad as the body; outside of this is a very broad band, only slightly narrower than this spot, colored and bordered like it, but broken and the parts removed successively inward to so great a distance at the uppermost and lowest median nervures, as to give the wing the appearance of being covered with a meaningless, irregular series of white stripes, whence Harris's appropriate name. At the two points mentioned, the outer white border of the lower portion of the band is nearly or exactly continuous with the inner white edging of the upper fragment and the inner edg-

ing of the portion embraced in the median area is usually continuous with the outer edging of white scales of the discal spot; so that were it not for the darker fields of the band itself and its outer limits of black, we could not readily make the markings of this species accord with the generic type; the different parts of the band take the general course of the discal spot, but above the subcostal nervure it is curved rapidly inward to the costal border, or, more frequently, is broken into small fragments by each succeeding nervule and the inner edging of a portion comes nearly or quite in contact with the outer edging of the discal spot again; at the lower extremity of the whole band, it usually narrows rapidly, sometimes abruptly, by the more or less gradual outward direction of the inner edging; outside of this band there is an interruptedly continuous series of transverse, curving, outward opening, black lines parallel to the outer border and placed, in the upper third of the wing, midway between it and the outer border of the extra-mesial band, bordered interiorly with white and followed outwardly by a tint like that of the extra-mesial band, but often with a faint, pale stripe down the middle; outer border with a distinct black line, edged interiorly with a narrower white line; costal border edged at base with dirty white; fringe of the tint of the wing. *Hind wings* with a discal spot and an extra-mesial band similar to those of the fore wings, but the discal spot is longer and the band more distinctly broken above, the uppermost fragment being in broken continuity (or nearly so) with the discal spot, while the inner edging of the succeeding patch is, normally, in direct continuity with the outer edging of the patch above and of the discal spot, and its outer edge in continuity with the interior border of the succeeding portion of the band; below the submedian nervure, the band takes an entirely different shape, its two portions forming a broad V whose limbs, sometimes parted, lie at an angle of about 45° with each other and are broader at their extremities than at their junction; the outer edge of the first portion is proximately in broken continuity with the inner edging of the discal spot and both its extremities are often edged, partially at least, with white—a tendency which is shared by all the fragments of the band on the hind wings and to some extent on the front pair. Beyond this band is a series of curving black and white streaks like those of the fore wings, but to a greater or less degree forming lunules, followed by distinct, bright orange lunules in nearly or quite all the interspaces, but especially in the median and anal areas, edged very narrowly in the upper median interspace and above it, with bluish white, occasionally with black followed by white; they are seated, in the lower median and lowermost interspaces, upon a roundish black spot (the junction of which is marked, next the inner border, by a small white spot) and in the intervening interspace upon a large blackish spot, flecked profusely with caerulean, but leaving between the two a black edging; outer border margined with black and white as in the fore wings; fringe and tails as above.

Abdomen above, of the color of the upper surface of the wings, at the sides more gray, beneath whitish, mingled next the sides with gray. The appendages of the male (34:17-19) having the lateral alations and arms of the upper organ as in *T. calanus* but the latter upcurved at the tip; clasp beyond the gibbous base conical, short, straight and blunt-tipped.

Measurements in millimetres. Length of tongue, 3.75 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	13.5	14.	15.	13.5	14.5	15.5
antennae.....		7.25			7.	
hind tibiae and tarsi....		4.25			4.25	
fore tibiae and tarsi....		3.1			2.9	

Described from 8♂, 9♀. Longer tails varying from 1.75 to 3 mm. in length.

Aberrations. T. L. PRUNA. Miss Guild captured, July 20, a male of this species with the colors of the under surface partly obsolete and partly suffused. The extra-mesial band is scarcely darker than the other dark parts of the under surface and its white edging has spread over various parts of the wing, giving them a whitish hoary appear-

ance; on the fore wings this is conspicuous only in the discal cell, between the discal spot and the mesial band, between the mesial band and the submarginal row of streaks, and, continuous with the latter, a curving streak, which follows, nearly to the base, the submedian nervure; the whole of the hind wings below the subcostal nervure, and, basally, below the costal nervure, inside the orange lunules, and excepting the extra-mesial band, is suffused with white, merging into brown toward the base of the wing. The white edging to the black margin of both wings is altogether wanting; the submarginal markings, excepting the edging just mentioned, and the orange lunules seated on black spots on the hind wings, are entirely absent and the general color of the dark parts more nearly approaches the color of the upper surface that is normal.

Secondary sexual peculiarities. For the male stigma see the description of the fore wing. The scales (46:18) which stand erect upon it hardly differ from those of *T. calanus* except in being strongly lobed at the base. They are a little more than three times as long as broad, with straight or scarcely convex sides, nearly equal throughout and as broad apically as basally.

Egg (65:17). Slightly flattened below, very broadly rounded above, pellucid white when empty, bristling all over with regularly tapering, slightly arcuate, almost acicular, bluntly pointed filaments, which arise from the angles of the cells, and on the sides nearly twice as long as the diameter of the cells. Cells polygonal, .018-.025 mm. in average diameter, bounded by walls which are quite as high or even twice as high as thick, perpendicular; above, the cells are smaller and the filaments shorter; the floor of the cells shows four or five thickened points. Filaments, .025-.034 mm. long and nearly or quite .005 mm. in diameter at base. Height of egg, .43 mm.; breadth exclusive of filaments, .65 mm.

Caterpillar. First stage (71:2). Head fusco-castaneous, deepening to black below; labrum and antennae pale; mandibles castaneous; ocelli black. Body pale green, above more or less pallid, uniformly besprinkled with black points. Posterior hairs of the laterodorsal row only half as long as those in front.

Third stage. Head green, edged in front with black, labrum green, mandibles roseo-castaneous; antennae pale green; ocelli black. Body pale grass green with slightly darker green dorsal line and oblique lateral stripes. Corneous disk of first thoracic segment transversely and irregularly diamond shaped; substigmatal fold pale; hairs pale fusco-roseate. Spiracles white; legs pale green, the claws castaneous.

Last stage (75:27, 32). Head (79:26) very pale greenish testaceous, with a rather broad transverse black belt from behind the ocellar area, crossing the frontal triangle just above the lower edge but broken at the edges of the triangle by the pale suture; ocelli and second joint of antennae of the color of the head; first joint of antennae and cardo white; labrum and mouth parts testaceous.

Body grass green, the lateral portions a little paler and with slight indications of paler, greenish yellow, slender, oblique stripes on the sides, besides some pale almost imperceptible mottlings above, more or less connected with the oblique stripes, and setting off a slightly darker dorsal line, which is most intense and distinctly margined with pale on the terminal segments. There is also a very faint and narrow substigmatal band, and on the first thoracic segment a dull brown, rhombic, dorsal shield with its posterior angle produced. The whole body is covered with spiculiferous, erect hairs, roseate brownish above, colorless below, most of which are short but have a tendency to be longer and slightly curved along the outer margin of the dorsal region, especially in front. They are seated on scarcely perceptible papillae, microscopically stellate by what are apparently thin clefts, six in number, radiating from the hair and covering an area .04 mm. in diameter. Spiracles pale testaceous, edged with a narrow testaceous rim. The skin has a shagreened appearance, with closely crowded shallow punctuations less than .01 mm. in diameter. Legs and prolegs (86:27) of the color of the body, the latter apparently trilobed, the claws testaceous. Length, .12 mm.; breadth, 3.5 mm.; height, 3 mm.; length of longer hairs, .3-.4 mm.; of shorter hairs, .15 mm.

Chrysalis (84:26). Dull, dusky, yellowish brown sometimes with a reddish tinge, pretty equally dotted with brownish fuscous, but most frequently along the inner border of the wings or on the abdomen above the spiracles, where the . . . sometimes form a broad indistinct band; a blackish fuscous dorsal line on the abdomen made up of similar accumulations of dots, and sometimes obscure. The network of interlacing ridges is darker than the ground color and forms moderately sized cells, covering most of the body but nearly obliterated on the sides, and indeed often scarcely to be noticed but for the little warts which occupy the angles and which are as large as above; the hairs are very abundant throughout the body and longer than usual, at the extreme front sometimes half as long again as on the back; they are white, erect or nearly erect, taper at the tip to a delicate point and bear delicate little spicules, nearly equal, sometimes nearly erect, from as long as half the width of the hair to its whole width, scarcely more than their own length apart. Spiracles luteous with white lips. Length, 9 mm.; breadth at thorax, 3.5 mm.; at abdomen, 4.5 mm.; height at thorax, 3.25 mm.; at first abdominal segment, 3 mm.; at middle of abdomen, 3.75 mm.; length of hairs, .2-.45 mm.; diameter of the papillae which support hairs, .03 mm.; of the papillae found at the intersection of the network, .02 mm.

Distribution (24:1). This butterfly is widely distributed although nowhere abundant; a member of both the Alleghanian and Carolinian faunas, it extends from the Atlantic border to Iowa (Parker), eastern Nebraska (Carpenter) and Kansas "rare" (Snow); and even to Manitoba (Tyrrell t. Fletcher), Dakota and Montana (Morrison) and eastern Colorado (Snow, Packard); southward it is recorded from Georgia "very rare" (Abbot) and Coalburgh, W. Va. (Edwards); and towards its northern limits from southern Michigan (Harrington), Adirondacks (Hill), Albany and Bethlehem, N. Y. "occurs rarely" (Lintner); and beyond our border at London (Saunders), Cameron Lake (Mead) and Ottawa, Ont. (Fletcher) and at Montreal (Saunders).

It appears to be found throughout New England, although everywhere considered a rare species. In Maine, it has only been taken, as far as I am aware, at Norway (Smith, Yale Coll. Mus.). In New Hampshire it has been reported from Mt. Moriah and Thornton (Faxon) and from Milford "very rare" (Whitney). In Massachusetts it has been found about Boston (Faxon, P. S. and F. H. Sprague, Harris, Minot, Dimmock), Walpole (Miss Guild), Andover (Treat), Springfield (Enory) and Williamstown (Seudder).

Oviposition. The only egg I have ever seen was one I found on a shadbush and had just been vacated by its owner, who was found upon a neighboring leaf. It had been laid upon the side of a twig, about two inches from the apical bud, under the leaf (65:17), as it were, of one of the old leaf-scars. It bore a striking resemblance to the gray lenticles scattered over the bark, a resemblance which could hardly fail to be protective.

Larval food plant and habits. The caterpillar of this butterfly has been found on a great variety of plants. Mr. Saunders has taken it on

thorn (*Crataegus*) and specimens received from him fed on apples; Dr. Dimmock has taken this or an allied species on apple; Mr. Lintner sent it to me as feeding on cultivated plums, and I have found it on shadbush, *Amelanchier canadensis* (all *Rosaceae*.) Mr. P. S. Sprague long ago found caterpillars and a chrysalis on *Vaccinium*, making it certain that it fed also on *Eriaceae*, and Dr. Dimmock has since taken the larva in some numbers on *Vaccinium corymbosum*; Abbot says that it lives on holly (*Ilex*, one of the *Aquifoliaceae*) and on "narrow leaved, jagged, black jack oak," which Dr. Chapman thinks is probably *Quercus catesbyi*, and this species is given in Abbot's drawings in the British Museum. Abbot also mentions *Quercus rubra* and adds that it feeds on other oaks, and my own caterpillars took readily to oak leaves; in some of Abbot's drawings which Dr. Boisduval received from Major LeConte is a memorandum by the latter that it also feeds on chestnut (another of the *Cupuliferæ*); and finally caged specimens which I had many years ago partook freely of willow (*Salicaceae*), and within a year or two I have found it in nature on the same tree.

On escaping from the egg, the little larva leaves a hole at the very summit about a quarter of a millimetre in diameter. At first the caterpillar eats holes through the leaf, but afterwards it eats holes or bites the edge indifferently; when fully grown and it is taking its meal at the edge of the leaf, the first thoracic segment completely covers the head and the edge of the plant so that one cannot see the operation. It is very inactive and prefers to remain on the leaf it has begun to eat, and sometimes does so even when decayed or dry before it will leave it for another fresh one actually touching it. Mr. Lintner found it burrowing into cultivated plums and eating out their interior, much as *Incisalia irus* does (*Rep. ins. N. Y.*, iv: 137).

Pupation. In getting ready for its change, the first indication of which is seen in a change of color from green to a pinkish brown, which comes on before they have ceased feeding, the caterpillar spins a very little silk and passes a girth around the body between the second and third thoracic segments; it then takes such a position on the silken carpet as to have the attached ends of the girth far in the rear, so as, apparently, to help remove the skin at the change. It takes, however, an exceptionally long time, from two to four days, to effect this change, and when it is accomplished the girth is found in the suture between the first and second abdominal segments.

A chrysalis found by Mr. P. S. Sprague was attached to the upper surface of a *Vaccinium* leaf, which, including the pedicel, was exactly the length of the chrysalis; the tightly drawn girth was attached to the outer edges of the leaf, which were thus drawn together, forming a sort of trough.

Life history. In the north the butterfly appears early in July. But few records of its capture are to be found before the 12th, but it has been bred by Dr. Dimmock between July 1 and 4 and by myself July 6 and 12 in different years; Mr. Lintner has also taken it on the 2d and 6th, and obtained a female at Albany on the 12th. It scarcely flies after the first of August (Mr. Sprague took one poor female at Leverett as late as the 14th) and the eggs laid in July continue unhatched until spring. The caterpillar makes its way through the shell at about the end of the first week in May, becomes fully grown from the middle to the latter half of June, and the chrysalis state lasts from twelve to sixteen days. In the south, according to Abbot, the butterfly appears quite early in May, after a chrysalis period varying from eight (?) to eighteen days, but there is no record of a second brood.

Habits of the butterfly. This butterfly appears to be somewhat local, and is never found away from thickets. Abbot says it "frequents oak fields and swamps"; it is fond of the flowers of sumac (*Rhus*). Its flight is very quick and nervous. While settling itself after flight it rubs its hind wings together, like its allies. When it starts to walk, the antennae, parted at about a right angle, are alternately depressed and elevated from a little above the plane of the body to a little below it. The front pair of legs, which when at rest are raised to the breast, are now brought into requisition, and even if there is nothing to touch, as there is not when walking on a plane surface, they are still alternately and constantly moved in the walking style.

When resting, it stands on four legs only, its body raised at an angle of about 30° with the ground, the wings erect, back to back, the lobes of the hind pair just clearing the surface, the costal margin of the fore wings brought forward so that the tip lies vertically over the base of the abdomen; while the antennae are spread at a right angle and elevated above the plane of the body so as to be nearly at right angles to the surface of rest.

Parasites. The only parasites certainly known are Tachinid flies which Dr. Dimmock raised in two instances, one on June 27 from a chrysalis which pupated June 17, too late to attack any more of this species the same year; the other emerged from a caterpillar found on apple; unfortunately the specimens have been misplaced.

A larva supposed to belong to this species, and which was found by Mr. F. G. Sanborn on *Vaccinium*, was fed to maturity and commenced to prepare for pupation by spinning a thin carpet of silk and passing a few threads over its thorax, when I noticed a discolored spot on the middle of one side between the last thoracic and first abdominal segments; the next morning a *Tachina* larva was seen to have left it on the side of the under surface of the second segment and to have changed to a pupa, the case of

which at first was pale yellowish brown but afterwards changed to a very dark mahogany brown; the segments were marked with very fine transverse lines, about .042 mm. apart, and at the posterior end had a band, occupying one-fourth of the segment, made up of seven or eight rows of minute bead-like prominences, crowded closely together, each row about .17 mm. wide; length of puparium, 4.75 mm.; breadth, 2.3 mm. The larva left the caterpillar on the 20th of June and emerged as a fly on July 2; it proved to be *Exorista theclarum* (89:17, 19), the same found on other *Lycaeninae*.

Another larva from this same plant, now presumed to belong to *T. liparops*, which I was trying to rear was found in a few days hanging by a short thread from a *Vaccinium* leaf while a parasitic grub was forcing its way out near the posterior extremity of its victim; when about half emerged, it began to weave a cocoon and after an hour's work had nearly completed one-third, when the thread broke and the whole fell to the ground; the grub now pushed its way completely out and constructed a new cocoon against the old one and on the bottom of the vessel; the cocoon was very delicate, made of white silk, 3 mm. long, and 1 mm. broad with some outlying tough threads to secure it to the surface on which it rested. Unfortunately the parasite, the only hymenopterous parasite known, died in the chrysalis state.

Desiderata. In view of the behavior of its allies, it would be interesting to discover whether the egg ever hatches before winter or, if not, whether the larva is fully formed within the egg before winter; one would think the summer the more favorable time for its development. Fuller descriptions of the earlier stages of the caterpillar are needed, and doubtless, from its polyphagous habits, many more new food plants are to be found. Its hymenopterous parasites are unknown.

LIST OF ILLUSTRATIONS.—*THECLA LIPAROPS*.

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|---|--|
| <i>Egg.</i> | <i>Imago.</i> |
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| <i>Caterpillar.</i> | 34:17-19. Male abdominal appendages; |
| Pl. 71, fig. 2. Caterpillar at birth. | top, rear and side views. |
| 55:27, 32. Mature caterpillars. | 46:18. Androconium. |
| 59:26. Front view of head in fifth stage. | 61:44. Papilla of tongue. |
| 86:27. Proleg seen from above. | <i>General.</i> |
| <i>Chrysalis.</i> | Pl. 24, fig. 1. Distribution in North America. |
| Pl. 84, fig. 28. Side view. | 80:17, 19. <i>Exorista theclarum</i> , a parasite. |

THECLA CALANUS.—The banded hair streak.

[Black hair streak butterfly (Abbot); banded hair streak (Scudder); banded hair streak butterfly; hickory slug caterpillar (Packard); banded hair streaked butterfly (Maynard).]

Rusticus armatus calanus Hübn., Samml. exot. schmett., 1, Lep. 1, Pap. II, Gent. 1, Rustici C. Armati b, figs. 1-4 (1806-19).

Strymon calanus Hübn., Ind. ex. Lep., 2 (1821).

Thecla calanus Doubl., List Lep. Brit. Mus., II: 30-31 (1847);—Scudd., Proc. Bost. soc. nat. hist., XIII: 272-276 (1870);—Butt., 128, 308, figs. 122, 160 (1881);—Middl., Rep. ins. Ill., x: 93 (1881);—Edw., Can. ent., xiv: 52 (1882);—Fern., Butt. Me., 80-81, fig. 26 (1884);—French, Butt. east. U. S., 263-265, fig. 73 (1886);—Mayn., Butt. N. E., 33-34, pl. 4, figs. 40, 49a (1886).

Polyommatus falacer God., Encycl. méth., ix: 600, 633 (1816).

Thecla falacer Boisdu-Rob., Lép. Amér. sept., 92-94, pl. 29, figs. 1-5 (1833);—Morr., Syn. Lep. N. Amer., 95 (1862);—Grote-Rob., Trans. Amer. entom. soc., 1: 172-173 (1867).

? *Thecla aurotorum* Boisdu, Ann. Soc. ent. Fr., (2) x: 288 (1852).

Thecla laurata Grote-Rob., Trans. Amer. entom. soc., 1: 323-324 (1868);—Saund., Can. ent., II: 61-64 (1870);—Grote, Can. ent., II: 165-168 (1870); xix: 179 (1887).

Papilio—Abb., Draw. ins. Ga., Brit. mus., VI: 50, figs. 162-164; xvi: 40, tab. 81 (ca. 1800).

Figured by Glover, Ill. N. A. Lep., pl. 28, fig. 5; pl. B, fig. 6; pl. E, figs. 15, 16; pl. I, fig. 6.

Là, chacun d'eux, à son tour,
Passe, comme une pensée
De poésie ou d'amour!

DE NERVAL.—*Les papillons.*

But if the while I think on thee, dear friend,
All losses are restored and sorrows end.

SHAKESPEARE.—*Sonnet.*

Imago (6:14; 14:11). Head black, the summit overarched by the projecting hairs of the prothoracic lobes, and in front either tufted (♂) or covered with appressed scales (♀); a broad band of snow white scales borders the eye in front and behind, connected, just above the tongue, by a transverse band of white scales and between the antennae by a narrow line of similar scales, intermingled with black hair. In front of the antennae; a narrow line of white scales borders the hinder edge of the space above the eyes, which is covered with short brown hairs instead of white scales, and also borders the outside and posterior border of the base of the antennae. Basal and middle joints of palpi covered with white scales, the apical third of the middle joint above and outside and a prolongation of the same downward upon the outer edge black; the black scales which break the continuity of the under portion of the white band encircling the eye form part of a broad band which crosses the base of the outside of the basal joint; apical joint blackish brown, white-tipped and with a few scattered white scales. Antennae velvety black, sometimes with a purplish tinge; the joints of the stalk and of the base of the club annulated at the base, not very narrowly, with snow white scales, which extend upward on each joint in little points upon the outer and inner edge beneath; at the base of the club beneath, there are a few additional scattered white scales, not forming a close patch and extending toward the tip of the antennae not more than a single joint further than above; club black, either covered beneath and at tip with exceedingly minute, scarcely paler olivaceous hairs (♂) or, the terminal three or four joints and a narrow line along the under surface, or sometimes even the whole of the under surface and sides, bright fulvous (♀). Tongue luteous, the edges faintly luteo-fuscescent.

Thorax covered above with bronze brown scales, mostly concealed by long and delicate, dark bluish gray and greenish gray hairs; prothoracic lobes covered with dark brown, pale-tipped hairs, posteriorly colored as on the thorax; beneath, the thorax is covered with soft mouse brown scales, mostly concealed by pearly white scales and hairs, having a bluish iridescence. Femora covered with dark brown scales, almost

or quite concealed by snow white scales; tibiae similar, but above more or less flecked with blackish and having always a subapical dark patch and sometimes a patch in the middle of the basal half; the dark colors are most conspicuous on the hind tibiae; tarsi bright luteous beneath, above black, narrowly annulate with white at the apices of the joints and broadly in the middle of the basal joint; spines black; claws dark reddish, brighter at base.

Wings above uniform dark glossy, almost blackish brown, with the slightest possible olivaceous reflection, the veins and outer edges blackish; the hind wings softer from the presence of numerous greenish gray hairs on the lower half; basal half of costal edge of fore wings fulvous; hind wings frequently (♀) or almost never (♂) possessing in the lower median interspace a small, submarginal orange patch, seated on a blackish spot and in the next lower interspace a few orange scales; outer border of hind wings in the same interspaces with a delicate line of pearly white scales seated upon the blackish edging of the whole wing; fringe of both wings light yellowish gray, blackish at base, excepting on the lower half of the hind wings, where between the tails, the fringe is pearly white, sometimes obscured with gray, blackish at base; below the lower tail it is blackish, narrowly pearly white at base; tails black-tipped, the longer fringed on the inner border with pearly white; there is a small patch of white scales at the excision of the inner margin, beneath which the fringe is blackish brown. Discal stigma (44:1) of the fore wings of the male rounded obovate, nearly twice as long as broad, slightly darker than the ground color. The portion of the subcostal nervure of the fore wings (61:5) of the male which lies on either side of the second superior nervule curves strongly downward a little beyond the middle of the cell; the vein connecting the inferior nervules to the main stem not transverse, but oblique; in these respects this species approaches *P. ontario* rather than its other congeners, but is not greatly different from *T. liparops*. Outer margin of the hind wings above the longer tail nearly straight, the longer tail more than half as long again as the width of an interspace, the shorter very slight.

Beneath uniform blackish slate brown (♂) or dark slate brown (♀), old specimens inclining to an ashy hue. Fore wings with the extremity of the cell covered by a subquadrate slightly darker spot, usually widest above, the outer and inner borders edged with bluish pearly scales; the middle of the outer half of the wing is crossed by a moderately broad stripe of confluent quadrate spots, slightly darker than the ground color of the wing, and darkest next the outer border, distinctly bordered externally and frequently (♀) or almost never (♂) very faintly upon the inner side with bluish pearly scales; the whitish external lining of each spot is usually more or less curved, opening inward, but is not infrequently straight; the direction of the band varies greatly; its general course is: starting from a point close to but not upon the costal border at about the middle of its outer half, it passes in a rather regular and slight curve toward the inner margin, gradually approaching the outer margin, as far as the lower median nervule and then turns inward again very slightly, and terminates at the submedian nervure, at about two-thirds the distance from the lower outer angle that its origin had from the upper outer angle of the wing; usually, however, it is abruptly, though but slightly, broken at the upper median nervule, being removed inward slightly at this point; the same thing usually occurs also at the lower median nervule; yet the band not infrequently continues on its course at this point and reaches still nearer the outer border at its very termination; occasionally the upper extremity of the band is bent abruptly inward or outward and, finally, the spots may be so related that the outer white edging forms either a nearly continuous, gradually curving line, or a series of little curves, or a series of dentations or steps, the angle not in the middle but at the lower corner of each spot; the width of the band also varies, in some being three or four times as wide as in others; usually it is about the width of the eye; it varies but little in general location, although in a few extreme specimens before me, it varies from the middle of the outer third to the middle of the outer two-thirds of the wing. Outside of this is a submarginal line of nearly or quite connected, delicate, transverse, blackish streaks, edged internally with white

scales, closely parallel to the outer border, but often bent inward at the upper extremity; it does not reach either border; the white edging sometimes forms a continuous line and sometimes a series of broad sagittate streaks; the outer side of the black streaks are occasionally flushed delicately, especially on the lower half of the wing, with orange; the outer margin is edged with black and the fringe is dull fuscous, darkest toward base. The extremity of the cell of the *hind wings* broadly bordered, as in the fore wings, with a slightly darker spot, but elongate quadrate in shape, deepest in color at the outer and inner border, where it is edged with bluish pearly scales; across the middle of the outer three-fifths of the wing runs a strongly curving, broken band, usually slightly narrower than the extra-mesal band of the fore wings, composed of partially confluent quadrate spots, a little darker than the ground color, edged on the outside distinctly, generally on the inside faintly, almost never on the upper or under sides, with bluish pearly scales; the whole band has a general direction closely parallel to the outer border, but composed of partially independent spots, the upper outer angle of each of which, in the upper half of the wing, is usually placed a little outside of the lower outer angle of the one above, that next the costal border lying about midway between the course of the band and that of the spot at the extremity of the cell; this rule never holds with the spot in the upper median interspace; the spots in the lower half of the band become elongate quadrate, that in the medio-submedian interspace either straight or nearly so, directed upward and inward from the submedian nervure, or is bent in the middle, the angle pointing inward; the lowermost forms a long, straight streak, never bordered on the inner side with whitish, running toward the base at right angles to the previous spot when the latter is straight, or to its under half when it is bent. Nearer the outer border of the wing than the outer border of this band is a row of very narrow blackish stripes, slightly curved on the upper half, strongly curved, opening outward, on the under half of the wing, bordered narrowly on the inner side with bluish, pearly scales; that in the lowest interspace varies from this, being a straight streak, parallel to that in the extra-mesal band; the whole of the medio-submedian interspace beyond this band is thickly powdered with bluish pearly scales; in the lowest median interspace, and to a much less degree in those following it, sometimes even as far as the upper subcostal interspace, and also slightly in the lowest interspace, this band is followed by orange lunules, seated, in the lowest median interspace, upon a black spot; the outer border is narrowly edged with blackish fuscous, followed by a slender line of bluish pearly scales; tails as on upper surface.

Abdomen above and at sides blackish brown, with a very dark, slight, violaceous reflection; at tip grayish yellow; beneath, white in the middle, dirty grayish white at the sides; alations of upper organ of male appendages (34: 24, 25) well rounded but apically slightly excised above, the lower edge straight, clasps nearly equal beyond the gibbous base, slightly curved downward.

Measurements in millimetres. Length of tongue, 5.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	14.	15.	16.	13.	14.	16.5
antennae.....	7.5	8.	8.5	6.25	7.5	7.5
hind tibiae and tarsi...	4.5	4.8	5.	4.	4.5	4.75
fore tibiae and tarsi...	3.	3.4	3.5	2.75	3.	3.25

Described from ♂, 26 ♀. Length of discal stigma 2.5-3 mm.

Secondary sexual peculiarities. For the male stigma, see the description of the fore wing. The scales of the same (46: 22) are slightly broader than in *T. edwardsii*, a little more than three times as long as broad, both extremities very broadly rounded, with rounded and subequal angulations; the sides are almost straight. They differ from those of *T. edwardsii* mainly in the rounded form of the base, this being less lobed than in any of our species excepting *T. ontario*.

Egg (65: 3). Prominences high, at the tip rough or even denticulate, and sometimes thickened, .04-.05 mm. apart, .025 mm. thick; the ridges are less than half their

height, uniform in elevation and .021 mm. wide; the spaces between the ridges are circular pits, .021 mm. in diameter, the bottom of which is covered with a few thickened white points, all but two or three of which are clustered around the periphery. Micropyle rosette (68: 1) .06 mm. in diameter, composed of a central circle, .004 mm. in diameter, surrounded by four oval cells directed toward it, their longer axes .018 mm. long, and their shorter .0125 mm. Height, .47 mm.; breadth, .7 mm. Color, according to Saunders, pale green.

Caterpillar. *Fourth stage.* Head pale greenish yellow, with a minute black dot on each side; mandibles pale brown, with a faint whitish patch immediately above them. Body above yellowish green, streaked above with yellowish white, and thickly covered with fine, short white hairs; first abdominal segment of rather a darker shade of green than the rest of the body. A dark green, dorsal stripe on the second and third thoracic and first abdominal segments, the full width of the dorsal crest; narrow on the four terminal segments, almost obsolete on those intermediate. A faint, whitish, dorsal line runs through the centre of this stripe. Dorsal crest edged with yellowish white, most apparent where it borders the darker portions of the dorsal stripe; sides of body with a few faint, oblique lines of yellowish white; substigmatal fold of the same color, which extends around the posterior segments. Under surface deeper bluish green, with a faint white bloom. Legs and prolegs concolorous. Length, 10 mm. (after Saunders). See also under next stage.

Last stage (75: 20). Head very pale green, the base of the triangle a very little infuscated; antennae pale, a fuscous spot at their interior base; ocelli pale in a black field; labrum white; mandibles reddish.

First thoracic segment dull, pale, dirty green; behind it a dark, brownish green, dorsal stripe, nearly twice as broad anteriorly as posteriorly, almost blackish from the second thoracic to the first abdominal, and on the sixth to ninth abdominal segments, bordered by a narrow, whitish band on the second to fifth abdominal segments, placed a little obliquely; this is again bordered with pale, dull, roseate patches, narrow in front and broadening behind on each segment; beneath this the sides are striped with narrow, oblique bands of whitish and greenish; the ventrostigmatal fold is pale bluish white, milk white on the seventh abdominal segment, and bordered with roseate above, excepting at the very tip; beneath bluish green; body completely covered with minute, white warts, emitting whitish hairs; spiracles white. Legs and prolegs bluish green; claws of former fuscous. Length, 13 mm.; breadth, 4 mm.; height, 2.5 mm.; length of long hairs, .48 mm.; of short ones, .16 mm.

Younger specimens, 9 mm. long (fourth stage?), show a more decided difference between the length of the hairs, showing that the change in this respect from the juvenile to the mature larva is gradual; in these the longer hairs were .25 mm. and the short ones .04 mm. in length. These specimens also had the dorsal stripe entirely wanting on the second to fifth abdominal segments, and sometimes the bordering line and the lateral markings were obscured. Later in life, with no change of integument, the dorsal stripe may sometimes become uniform in color over the whole body.

Other full grown specimens, taken at first both by Mr. Saunders and myself to be quite distinct, offer so many points of difference that I add a description of one of them in full; it is the other extreme of the variation (75: 26). Head very pale greenish with a brownish tinge, the base of the triangle with a broad black band; antennae with the basal joint white, beyond very pale greenish brown; ocelli white in a black field; labrum white; mandibles reddish brown.

Body bright velvety grass green; a faint, narrow, paler, dorsal line, from the middle of the second thoracic to the sixth abdominal segment, bordered by a darker line, more distinct posteriorly, and behind the sixth abdominal segment forming a not very broad dorsal band; this again is bordered, distinctly only on the posterior segments, with paler green; on the sides of each segment there is a narrow, indistinct, oblique, pale streak, bordered on either side, but more conspicuously below, with darker green; the ventrostigmatal fold is paler green, bordered above by a broader band of darker green; hairs reddish brown; spiracles pale brownish, the posterior half more dis-

tinently marked. Legs very pale greenish, the last joint a little infuscated externally. the tips of the claws reddish brown; prolegs grass green, pale at tips. Length, 13 mm.; breadth, 3.5 mm.; height, 3 mm.; length of longer hairs, .48 mm.; of shorter hairs, 12 mm. See also Mr. Saunders's descriptions and comments (Can. ent., 11: 61-64).

Chrysalis (84: 25, 27). Thorax, wings and appendages dull, pale green, the thorax a little dusky and abundantly dotted with small, blackish fuscous spots, arranged to a certain extent in streaks of varying disposition on the prothorax and the upper portion of the sides of the mesothorax, the former sometimes with a distinct, blackish, dorsal line, which becomes interrupted behind; the wings with a few scattered dots on the upper half. Abdomen pale yellowish or reddish brown, sometimes with a dirty, roseate tinge; a pale reddish, dorsal streak, marked irregularly, and sometimes centred with black and bordered by a pale, whitish band, obscured by yellowish brown; sides profusely spotted with blackish fuscous, and bearing a lateral row of small, round, blackish spots, which connect below with some blackish fuscous spots, and thus form short, transverse streaks. The network of scarcely elevated, interlacing ridges is composed of rather larger cells than in most of the species, covering most of the body, and as distinctly on the sides as on the back, having no greater elevation at the intersection; the hairs are pretty abundant, pale yellowish, moderately long, nearly equal until close to the tip, where they taper to a fine point, fully half as long again on the front as on the sides; they are very minutely and delicately spiculiferous, the spicules seldom visible as more than raised points, never exceeding one-fourth the diameter of the hair, directed well forward, distant from each other generally by the width of the hair. Spiracles pale green, with reddish lips, or reddish brown with pale lips. Length, 9 mm.; breadth, 4.25 mm.; height, 3.75 mm.; length of hairs in front, .36 mm.; length of hairs on body, .23 mm.

From specimens bred on oak and received from Mr. Saunders.

Another description. Greenish brown, more or less fuliginous, the raised tracery of surface more or less infuscated. There is an obscure dorsal stripe on the prothorax and front of mesothorax, obscured by fuliginous; sides of mesothorax tinged with fuliginous. Abdomen above with an obscure dorsal stripe, most distinct and broadest on the third segment; and a series of dark, infralateral dots in the middle of the segments, which become large, oblique, blackish blotches on the fourth to sixth segments; between this series and the wings, and including nearly the whole of the second segment, the abdomen is light yellowish brown; spiracles faintly brownish fuscous. Wings dull, but pale luteous, flecked with brown, the basal tubercle marked above with black. Eyes black, conspicuous; prothoracic spiracle pallid. Beneath wood brown, the apical halves of the appendages infuscated, the antennal clubs blackish; an infuscated, ventrolateral band on abdomen. Hairs straight, slightly tapering, bluntly pointed, faintly spiculiferous. Length, 10.5 mm.; breadth of abdomen, 3.5 mm.; of front of mesothorax, 2.7 mm.; length of hairs on thorax, .15 mm.

Described from specimen bred on butternut and sent by Mr. Hulbert.

Distribution (24: 2). This is much more extensively distributed than the preceding butterfly, at least in latitude, being common to the Alleghanian and Carolinian faunas and even encroaching a little on the Canadian. Southward it occurs in Georgia "common" (Abbot), Alabama (Gosse) and Virginia (coll. Amer. ent. soc.). Westward it reaches to Michigan (coll. Mich. Univ.), Wisconsin "not rare" (Hoy) and Iowa,—Des Moines (Austin) and New Jefferson (Allen); and even to eastern Nebraska (Carpenter), eastern Kansas rare (Snow), Colorado and New Mexico (Snow), and northern Texas. If Boisduval's aetorum be the same, as is probable, it even extends to California. Northward

Mr. Saunders reports that it is "comparatively common" at Montreal* "where *edwardsii* is either unknown or comparatively rare" and it has also been found at London, Ont. (Saunders, Reed) and Ottawa, abundant (Billings, Fletcher).

It seems to occur throughout most of New England, but has been taken in Maine only at Norway (Smith); in New Hampshire it has occurred at Walpole "quite common" (Smith) and Milford (Whitney); in Vermont at Bellows Falls (Merrill); in Massachusetts at Andover (Treat), Woburn (Shute), Dorchester (P. S. Sprague), Wollaston and Quincy (F. H. Sprague), Cape Cod (Fish), Amherst (Parker), Springfield abundant and Mt. Tom (Emery), Leverett, Mt. Toby and Montague (F. H. Sprague); in Rhode Island at Providence (Packard), and in Connecticut at Plantsville (Shepard in Yale Coll. mus.) and New Britain (Hulbert).

Food plant and habits of caterpillar. Mr. Saunders has bred this caterpillar upon oaks, and Mr. Abbot states that it feeds on red oak (*Quercus rubra* Linn.) and other oaks (in his British Museum manuscripts *Q. falcata* Michx. is figured); and he adds that it feeds also on hickory (*Carya*), a member of a neighboring family. Dr. Packard has found presumably this species on *Carya glabra* Torr., and Mr. Hulbert has bred it on the allied butternut, *Juglans cinerea* Linn. Boisduval and LeConte, however, state that it feeds on species of *Crataegus*, a genus belonging to another division of angiosperms, and this somewhat doubtful statement has been extensively copied without verification; a specimen of the imago in the museum of the Michigan University, however, is labelled "thorn"; and I find in Abbot's manuscript a statement that it feeds on "parsley haw," by which a *Crataegus* is probably meant.

It devours the leaves by eating holes through them, not touching the edge; it is rather slow in its movements, differing considerably in this respect from *T. edwardsii*. It is a cannibal, too, in its small way and when short of food has been seen to devour its younger and weaker brethren.

The caterpillar varies greatly in markings, as may be seen by our illustrations, in which extreme types are represented, one being grass green and almost immaculate, the other of an impure color and marked with a broad and greatly interrupted dorsal stripe; no one would at first take them to be identical.

Seasons. The butterfly makes its first appearance toward the end of June, and continues to emerge from the chrysalis until after the first week in July—the females probably throughout July. It is much more abundant during July than subsequently, but occurs also during the whole of August and has even been taken in the first week of September, but

*Caulfield says, generally rare, but abundant in 1874.

whether taken in June or September, all belong to one brood. The eggs, which I have received from Mr. Saunders, are laid all through July and early in August, and perhaps sometimes remain unhatched throughout the winter. At other times, as in cases recorded by Saunders and Worthington, they hatch in a few days, but in each case these died. It is tolerably certain that if they hatch, they hibernate without eating (as the action of Mr. Worthington's caterpillars would indicate), and that the egg may also hibernate,* as there is no indication of a second brood, even in the south. Eggs which I received from Mr. Saunders early in August did not hatch, and caterpillars found in the spring after the vegetation is out are only partly grown, again both in the north and in the south. It is usually not until toward the last of June in the north, sometimes not until July, that the larvae become full grown, and after passing fourteen to twenty days in chrysalis (Hulbert), emerge as butterflies. In the south, judging from the observations of Abbot and Gosse, the butterflies emerge late in April or early in May, after twelve days in chrysalis. Neither makes any allusion to a second brood.

Behavior of the butterfly. In Georgia, according to Abbot, these butterflies are found in oak woods and frequent the blossoms of "Chinquessin" [? Chinguapin, *Castanea pumila* Michx.]. In the west, Allen took them in company with *T. edwardsii* "on flowers of the *Symphoricarpos* which grew on the prairies, in hollows that were moist in the spring time. They were also found at the bottom of ravines, in a low, thick growth of timber." Caulfield finds them on blossoms of *Asclepias* and *sumac*. Lintner's specimens "were usually captured when resting on bushes after a short and rapid flight in the warm sunshine."

Gosse, speaking of *Theclidi* in general, and of this species in particular, says (Lett. Alab., 37) "when at rest they often rub the surfaces of the hind wings upon each other, up and down alternately."

It is not a little strange that, while out of nine specimens bred by Messrs. Saunders and Reed, seven were females, the proportion of males to females in specimens captured at large (out of ninety-five examined) is as three to one. Is it possible that the females instinctively conceal themselves in the thick foliage of trees?

Parasites. The caterpillars, although so small, are not free from the attacks of a dipterous parasite; *Exorista theclarum* (89:17, 19) lays its eggs in the body of the larva, usually but one egg in each insect, although Mr. Saunders once obtained three *Tachinae* from one caterpillar. The puparium is of a "dark brownish red" color, 4.8 mm. long; one hatched July 11. Packard bred (*Proc. Bost. soc. nat. hist.*, xxi:34) from this caterpillar in June a *Tachina* fly, and Mr. Hulbert found a maggot in

*That the chrysalis may hibernate, as believed by Edwards (*Can. ent.*, xiv:52), the facts then published, but not noticed by him, abundantly disprove.

September in each of three chrysalids he expected to hibernate; both of these may belong to the same species of *Exorista*. Besides this the caterpillar is attacked by a species of *Tetrastichus*, *T. theclae* (89:6) which once came from a chrysalis reared from some larvae sent me by Mr. Saunders; only males were obtained.

Desiderata. Is the larva ever found on thorn? When do the eggs hatch? and if in the summer, what do the young caterpillars do, or where betake themselves? What are the characteristics of the early stages of the caterpillar? In what terms shall we describe the flight and postures of the butterfly? Are the males really more abundant than the females? Those wishing to obtain parasites may be sure that wintering chrysalids contain them.

LIST OF ILLUSTRATIONS.—*THECLA CALANUS*.

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| <p><i>General.</i></p> <p>Pl. 24, fig. 2. Distribution in North America.
89:6. <i>Tetrastichus theclae</i>, a parasite.
17. <i>Exorista theclarum</i>, a parasite; head.
19. <i>Exorista theclarum</i>, a parasite; wing.</p> <p><i>Egg.</i></p> <p>Pl. 65, fig. 3. Plain.
68:1. Micropyle.</p> <p><i>Caterpillar.</i></p> <p>Pl. 75, fig. 20, 26. Side views.</p> <p><i>Chrysalis.</i></p> <p>Pl. 84, fig. 25, 27. Side views.</p> | <p><i>Imago.</i></p> <p>Pl. 6, fig. 14. Female, both surfaces.
14:11. Male, both surfaces.
34:24. Male abdominal appendages, side view.
25. The same, viewed from below in outline.
44:1. Stigma of fore wing greatly enlarged.
46:22. Androcorium from the stigma.
61:5. Neuration, fore wing ♂.
6. Neuration, fore wing ♀.</p> |
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THECLA EDWARDSII.—Edwards's hair streak.

[Edwards's hair streak (Seudder); Edwards's streaked butterfly (Maynard).]

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| <p><i>Thecla edwardsii</i> Saund., MSS., [see Trans. Amer. entom. soc., 1: 172 (1867); Can. ent., 1: 98-99 (1869)];—Seudd., Proc. Bost. soc. nat. hist., xlii: 272-276 (1870);—French, Butt. east. U. S., 261 (1866);—Mayn., Butt. N. E., 33, pl. 6, figs. 39, 39a (1886).</p> <p><i>Thecla falacer</i> Harr., Ins. inj. veg., 3d ed., 276 (1862);—Grote, Can. ent., 11: 165-168 (1870); xix: 179 (1887).</p> <p><i>Thecla calanus</i> Grote-Rob., Trans. Amer.</p> | <p>entom. soc., 1: 172-173 (1867);—Saund., Can. ent., 1: 98-99 (1869);—Middl., Rep. ins., 111, x: 93 (1881).</p> <p><i>Thecla fabricii</i> Kirb., Syn. catal. Lep., 654 (1871).</p> <p>Figured in Glover, Ill. N. A. Lep., pl. I, fig. 4, ined.</p> <p>(Not Polyom. falacer God.; nor Rust. arm. calanus Hüb.)</p> |
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The wild bee and the butterfly
Are bright and happy things to see;
Living beneath a summer sky.

ELIZA COOK.

Sie tanzen und tanzen wohl allzumal
Um eine Linde im grünen Thal.

KERNER.

Imago (6:16). Head blackish brown, the summit overarched by the prothoracic hairs; a broad band of snow-white scales borders the eye in front and behind, connected, just above the tongue, by a transverse band of white scales; a few pale scales are arranged along the median line of the vertex; posterior outer border of the basal joint of antennae edged with white scales. Apical half of basal joint of palpi cov-

ered with dark brown scales, the continuation of those which break the continuity of the white band encircling the eyes; outside of middle joint half white, half black, divided by a line, running from the middle of the apical half of the upper edge to the middle of the basal half of the lower edge; inside of basal and middle joints white with a few brownish scales; terminal joint black, white-tipped, and with a great many white scales at the base, particularly above and beneath; sometimes the basal half, excepting the sides, white. Antennae blackish brown, each joint of the stalk and the basal ones of the club rather broadly annulated at the base, the white scales frequently confluent and forming an elongate triangular patch at the base of the club, especially in the male, on either side of a luteo-fulvous patch (generally more or less obscured with fuscous in the male) which extends over the whole under surface of the club, broadening toward the tip and occupying the whole circumference of the terminal three or four joints. Basal half of tongue luteo-testaceous.

Thorax covered above with obscure mouse brown hairs, scarcely tinged with olivaceous; prothoracic lobes covered with dark brown, mingled with some pale and gray hairy scales, sometimes with a greenish tinge; beneath, the thorax is gray with longer bluish white and shorter blackish hairs; femora covered with white scales, speckled more or less with blackish brown, beneath covered with long white hairs with a few intermingled black ones; remainder of legs dull luteous, obscured above mainly with blackish brown scales and a few whitish scales (the latter especially at the apices of the joints, and a subapical patch on the tibiae), on the sides mainly with white, with scattered blackish scales; spines black, claws blackish, tinged with red.

Wings above uniform dark grayish slate brown, occasionally almost blackish brown, fresh specimens with an exceedingly slight olivaceous reflection, the veins, usually in the male only, and the outer edges blackish brown; basal half of the costal edge of the fore wings indistinctly fusco-fulvous. Hind wings almost always (♀) or usually (♂) having in the lower median interspace, very seldom also in the medio-submedian in the female, a submarginal, generally small orange patch (when most distinct, developed as a high lunule) seated on a blackish spot, the latter generally obsolete; outer edge of the hind wings with a line of pearly white scales as in *T. liparops*; discal spot on fore wings of male oblong obovate, three times as long as broad, obscure dark grayish fuscous; subcostal nervule of the fore wings on either side of the origin of the inferior nervule considerably curved downward one-third way across the cell, at about the middle of the outer two-thirds of the latter; upper cross vein closing the cell transverse and in continuation of the lower; outer margin of hind wings above the longer tail straight, the latter but little longer than the width of an interspace, the shorter one very slight.

Beneath uniform ashy slate brown, the extremity of the cell in each wing marked by a spot very slightly darker than the ground color of the wing, and agreeing in every other particular with the same spot in *T. liparops*; both wings are crossed by an extra-mesial band, the general course and position of which, in all its variations, corresponds to the similar band in *T. calanus*; but it is made up of entirely independent, though closely contiguous and sometimes even partially confluent, spots of a blackish brown color, completely encircled, although less distinctly above, below and on the inner side, with white; the spots of the fore wings vary greatly in shape; usually they are transversely short obovate, the upper ones roundish, the lower often quadrate or reniform; on the hind wings those above the lower median nervule are roundish, with a tendency to become transversely short obovate. Outside of this band, on the fore wings, is a submarginal continuous stripe of slender, transverse, blackish streaks, closely parallel to the outer border, edged narrowly on the inner side with white scales and followed externally by a delicate flush of orange, generally quite inconspicuous and often very nearly obsolete; a similar submarginal series on the hind wings formed of curved, or, on the lower half, usually of sagittate spots, opening outwardly, followed by more distinct orange spots, especially next the anal angle and in the lower median interspace; in the medio-submedian interspace the orange is reduced to a mere edging, and the rest of the interspace is filled with abun-

dantly scattered caerulean scales on a dark ground; outer border of both wings marked narrowly with blackish brown, on the hind wings and often on the lower portion of the fore wings, followed interiorly by a line of white scales; a black spot at the extreme anal angle, following the line of white scales on the lower median interspace; fringe and tails as in *T. calanus*, except in being of the general color of the wings.

Abdomen above of the color of the upper surface of the wings; at the sides grayish and beneath dirty white; alations of upper organ of male appendages (34:14) well rounded, the lower edge almost straight; claspers straight tapering slightly beyond the gibbous base.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of 3 discal spot 2-2.6.						
Length of fore wings.....	13.5	14.5	15.25	13.	15.75	17.25
antennae.....	7.75	8.15	8.5	6.5	7.5	8.75
hind tibiae and tarsi..	4.	4.5	5.	3.75	5.	4.5
fore tibiae and tarsi..	3.	3.25	4.15	2.5	3.25	3.6

Described from 62 ♂, 38 ♀. Longer tails varying in length from 1.75 to 3.25; aver., ♂ 2.1, ♀ 2.75.

Secondary sexual distinctions. See description of fore wing for the appearance of the male stigma. The scales found there (46:20) are ribbon-like, scarcely tapering, the sides being parallel, the tip well rounded and hardly angulated, while the base is angulated, equally on both sides; the lamina, exclusive of the stem, is a little more than three times as long as broad, and differs from that of *T. calanus* in its greater slenderness and the inequality of form of the two extremities.

Egg (65:2). Prominences very high, smooth-tipped, .064 mm. apart, .025 mm. in diameter, the ridges rather slender, uniform, abrupt, .0085 mm. thick; pits angular, and at most .025 mm. in diameter, the bottom marked as in *T. calanus*; at the summit assuming much more the appearance of pits, occupying scarcely more than half the otherwise uniform surface. Micropyle rosette (68:2) .07 mm. in diameter, composed of a minute central circle, surrounded by four oval cells, directed toward it, their longer axes .03 mm. long and their shorter half of that. Height, .44 mm.; breadth, .82 mm.

This egg may be distinguished from that of the preceding species by the smoothness of the tips of the prominences and their greater distance apart; also by the nature of the interspaces, which are not circular pits, as in that species, but agree better with the similar parts in *Incisalia*.

Caterpillar. *Fourth stage.* Head shining pitchy black, the base of the triangle with a white or pellucid narrow band.

Body scarcely tapering in advance of the seventh abdominal segment, the extremity very bluntly pointed; grizzly brown, marked with dull, dirty pale yellowish brown; dorsum of the first thoracic segment and a dorsal stripe, excepting on the anterior edge of the second thoracic segment, grizzly brown, the stripe distinctly bordered as far as the seventh abdominal segment, narrowing posteriorly; the rest of the body above dull dirty pale yellowish, the sides of each segment with a short and broad oblique streak of grizzly brown, the upper edge only of which is well defined because faintly bordered with dirty whitish; the ventrostigmatal fold is paler than the upper surface and is bordered above with a very indistinct band of obscure yellowish brown; under surface of body pale, dull, bluish green; warts blackish and their hairs pale brownish, giving the body a speckled appearance; the second and third thoracic and the first to third abdominal segments have each three blackish spinous hairs in the laterodorsal row, the middle the longest; the fourth to seventh abdominal segments have two each, of equal length; spiracles whitish encircled with dark brown; legs pale greenish, infuscated externally. Prolegs pale, dull bluish green. Length, 5.5 mm.; breadth, 1.5 mm.

Last stage (75:25) not differing from the previous. Length, 9.25 mm.; breadth, 3 mm.

Mr. Saunders's description differs somewhat from mine and particularly in that he found the dorsal band "enlarging to an indistinct patch at each extremity, most prominent on hinder segments and having a series of spots along its centre from fifth to ninth [first to fifth abdominal] segments inclusive of dull greenish gray, the hinder ones being almost diamond shaped." His specimens were 15 mm. long.

Chrysalis (84:29). Dull yellowish brown, slightly glossy, with many small spots of a darker shade of brown frequently collected into irregular streaks and blotches, particularly in an obscure band along the latero-stigmatal region of both thorax and abdomen and a ventral stripe on the abdominal segments. The network of interlacing ridges is composed of smaller cells than in the other species, covering most of the body, as distinct on the sides as on the back and having at their intersecting angles little warts; the hairs are rather distant, very short, as long on the body as on the front, excepting some on the very front edge of the prothorax which are fully three times as long as the others, tapering throughout, but bluntly pointed, distinctly and very minutely spiculiferous; the other hairs are equal, bluntly rounded at tip and their spicules so excessively minute as scarcely to be distinguished with a high magnifying power; spiracles luteous. Length, 10 mm.; breadth, 4.5 mm.; height, 4.25 mm.; length of hairs in general, .065 mm.; length of hairs on anterior edge of prothorax, .2 mm.

Distribution (24:3). This butterfly is a member of the Alleghanian fauna, occupying a comparatively narrow strip of territory, so far as known, from the Atlantic more than half way across the continent. It is rarely found north of Lat. 42°, nor, in the east, often south of 40°. West of New England, the northernmost points at which it has been taken are Albany, N. Y. (Lintner), London, Ont. abundant (Saunders), Beloit (Chamberlain) and Racine, Wis. (Hoy), northern Illinois (Worthington), and in some abundance at several places in Iowa (Allen, Austin), where specimens are larger in size. In the extreme west it has been found in Nebraska (Edwards) and at several places in Colorado—Manitou (Packard), Ute Pass (Scudder) and the east slope of the Sangre de Cristo Mts. (Frazer). Besides this it is reported as "rare" at Summit, N. W. Terr., Long. 115° W., 50° N. by Geddes! Strecker gives it from Texas but without specification, and it must be believed erroneously. In the east its southern limits are doubtful (as indeed everywhere) owing to the confusion of names in the memoranda received from different persons. A single specimen in the collection of the American Entomological society is marked Virginia with a query, and it is possibly this species which is reported from Pennsylvania (Blake) and Maryland (Uhler); but Mr. Edwards has not found it in his extensive collections in West Virginia and the most southern localities from which I have seen it are in New England.

Here it reaches the southernmost boundaries and extends northward into the southernmost portions of the northern states, being apparently limited on the north very closely by the line I have marked out as that dividing the Alleghanian and Canadian faunas. In Maine it was not found by Professor Fernald at Orono, but a single specimen has been taken by Miss Wadsworth at Hallowell; and in New Hampshire it has been found at Nashua (Harr. Coll.) and Milford (Whitney). Most of the captures

have been in Massachusetts, where it has been found about Boston by everyone, at Andover (Sanborn), Amherst (Merrill, Parker), several other places in the Connecticut Valley, such as Deerfield, Leverett and Mt. Toby (Sprague), and Springfield abundant (Emery), as well as on Cape Cod (Fish) and the island of Nantucket, where it is extremely abundant.

Haunts. In Nantucket the butterfly is confined exclusively to the immediate vicinity of the roads through the scrub oaks; elsewhere they are not to be found, not even on the edges of the oak shrubbery. Mr. Saunders writes from London, Ont. :—

The butterfly is never found in wet places where willows are abundant but on dry ground where oak bushes are common; unless when settled on flowers in the vicinity, they were almost invariably found on these oak bushes, sometimes on the under surface of a leaf, as if searching for a suitable place of deposit for eggs; when they were driven from these they returned in a short time as if their business among these shrubs was too important to be set aside.

Food plant and habits of caterpillar. The caterpillar, which has only been found by Mr. Saunders, feeds upon oak, eating small holes in the leaves. To judge from the abundance of the butterfly on the island of Nantucket, it is probably found on *Quercus ilicifolia*. Miss Middleton adds hickory as a food plant, but probably by confusing it with the preceding species with which it was formerly confounded: in the ornamentation of the larva the two are very distinct. It is, however, not absolutely certain that the larva here described belongs to this species, since it has never been reared; but as Mr. Saunders has found the butterfly abundantly and always about oak bushes and since this larva was obtained by beating the same bushes later in the season, and there is no other species to which it can be referred without involving great difficulties, one can hardly help accepting Mr. Saunders's theory; yet the comparative scarcity of the caterpillar and abundance of the butterfly is certainly curious. The caterpillar moves about with comparative rapidity, in marked distinction to the sluggishness of the allied species.

Life history. The butterfly is most abundant in July. According to Mr. Lintner's observations, it appears sometimes as early as the 22d of June, but usually not until the 10th of July; toward the last week of this month the females begin to outnumber the males, and they continue upon the wing throughout August, in the latter part in scanty numbers, and are now and then seen during the first week of September. In Nantucket one year I found both sexes abundant and fresh, though some females torn, on August 3; three-fourths of a large number captured were females; on the 5th they were slightly less abundant and less fresh, especially the males. Probably most of the eggs are laid early in August, though I have taken a pretty fresh female as late as August 28; they doubtless continue throughout the winter, although Mr. Saunders writes

that some eggs deposited in confinement hatched late in the same season. I think this must be exceptional, but, if not, then the insect must winter as a young larva. The caterpillar becomes full grown in June and the chrysalis may be looked for from the middle of June to the middle of July; its duration is unknown.

Flight and attitudes. It is an exceedingly lively insect, and it is difficult to follow one in its rapid, changeable flight. It is very pugnacious, one seldom stirring out without meeting and having a tussel with a fellow; it will dash out at every passing grasshopper. The male far exceeds the female in activity. When alighted the wings are held erect, the under pair covering half the lower median interspace of the fore wings; the antennae, curving forward at the extreme base, are straight, raised at about an angle of 20° with the body and divaricate about 80° . When not so alert, in the shade, the antennae may divaricate as much as 100° and be dropped to the same plane as the body. In walking on a perpendicular surface, it uses all six legs, but when it stops it withdraws to the breast one or both the fore legs. I have only once or twice seen them rub their hind wings, and it then appeared as if both hind wings were moved together over the fore wings, and not alternately.

Parasites. Mr. William Saunders found some chrysalids of this butterfly which he reared infested by *Tetrastichus saundersii*, which hibernated in the chrysalis case and made its appearance after the butterflies of the following year were upon the wing.

Desiderata. Our first object must be to raise this insect in order to prove that the supposed earlier stages are really its own, and to secure full descriptions of the earlier stages of the caterpillar; our next to determine in what stage it passes the winter. Notes upon the southern and north-western distribution of the butterfly are also desirable. Does its parasite attack other caterpillars? If not, and, as appears from above, it escapes from the chrysalis only after the next season's caterpillars are gone, what does it do with itself till they come again?

LIST OF ILLUSTRATIONS.—THECLA EDWARDSII.

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| <p><i>General.</i></p> <p>Pl. 24, fig. 3. Distribution in North America.</p> <p><i>Egg.</i></p> <p>Pl. 63, fig. 2. Plain.</p> <p>68: 2. Micropyle.</p> <p><i>Caterpillar.</i></p> <p>Pl. 75, fig. 25. Dorsal view.</p> <p><i>Chrysalis.</i></p> <p>Pl. 84, fig. 29. Side view.</p> | <p><i>Imago.</i></p> <p>Pl. 6, fig. 16. Male, both surfaces.</p> <p>34: 14. Male abdominal appendages.</p> <p>39: 11. Neuration.</p> <p>46: 20. Androconium.</p> <p>54: 8. Side view of head and appendages enlarged, with details of the structure of the legs.</p> |
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THECLA ACADICA.—The Acadian hair streak.

(The Acadian hair-streak (Scudder): the pale streaked butterfly (Maynard).)

Thecla acadica Edw., Proc. Acad. nat. sc. Philad., 1862, 55, pl. 1, figs. 3, 4 (1862); Butt. N. Amer., 1, *Thecla* 1, fig. 5-7 (1869);—Pack. Guide Ins., 265-266 (1869);—Saunders, Can. ent., 1: 95 (1869);—Middl., Rep. Ins. Ill., x: 93 (1881);—French, Butt. east. U. S., 260-261 (1886);—Mayn., Butt. N. E., 34, pl. 6, figs. 41, 41a (1886).

Thecla californica Edw., Proc. Acad. nat. sc. Philad., 1862, 223 (1862).

Thecla sonhegan Whitt., Proc. Bost. soc. nat. hist., xii: 162-163 (1868).

Thecla borus Boisdu., Ann. Soc. ent. Belg., xii: 43 (1869).

Thecla cyaneus Edw., Trans. Amer. ent. soc., iii: 207-208 (1871).

Figured by Glover, Ill. N. A. Lep., pl. 98, fig. 17; pl. II, fig. 5; pl. M, fig. 11, fued.

... To the shady grove he wings his way,
And feels in hope the raptures of the day—
Eager he looks; and soon, to glad his eyes,
From the sweet bower, by nature form'd, arise
Bright troops of virgin moths and fresh-born butterflies;
Who broke that morning from their half-year's sleep,
To fly o'er flowers where they were wont to creep.

CRABBE.

Mine eye and heart are at a mortal war
How to divide the conquest of thy sight.

SHAKESPEARE.—*Sonnet*.

Imago (6: 13). Head velvety black, tufted above at hinder edge with blackish brown; beneath, snow white; the eyes encircled with snow white scales, interrupted narrowly below and broadly above; vertex with a slight median tuft of white hairs; outer base of antennae edged with white; outer edge of dark patch behind antennae bordered with white. Antennae purplish black, the base of the joints broadly annulated, especially beneath, with snow white, coalescing at the base of the club beneath into an elongate patch; club velvety black, the last two or three (♂) or four (♀) joints, rarely the whole under surface, faintly (♂) or brilliantly (♀) colored with orange, which in the male is always obscured with fuscous. Basal joint of palpi white, tipped with black on the outside, the middle joint white on the inside and above, excepting a large black spot at the tip above; and on the outside, excepting broadly at the tip and beneath, nearly to the base; terminal joint black, slightly tipped with white and with a broad white annulation at the base, interrupted on the upper inner edge. Tongue dull luteous.

Thorax covered above with long mouse gray hairs concealing shorter paler hairs and scales; prothoracic lobes covered with mingled brown and gray hairs; beneath, the thorax is covered with bluish hoary and silvery gray hairs. Femora iridescent pearly white, speckled with a few blackish scales; beneath blackish obscured by the profuse beard of silvery gray hairs; tibiae like the femora with a large, subapical, external, blackish patch; basal third of basal tarsal joint blackish; the rest of the joint grayish white, beneath luteo-fuscous; other joints black, tipped with white; spines black; claws blackish red.

Wings above uniform, soft, lustrous, blackish slate brown, worn specimens with a very slight olivaceous tinge, the veins, and to a very slight degree the edge of the discal spot on the fore wings of the male, blackish; costal edge of fore wings, especially near the base, tawny; outer edge of both wings distinctly but narrowly bordered with black; in the lower median interspace of the hind wings and generally, to a less extent, in those succeeding it, a rather large, submarginal, orange, lunate patch, seated upon a transverse blackish striga and separated, by a slender line of pale bluish white scales, from the black border; fringe of fore wings and of the upper half of the hind pair fuscous at base, pearly fuscous beyond, with a very inconspicuous pale median line; in the lower median interspace of the hind wings and at the extreme anal angle blackish at base, white beyond; between the two, black with a median white line; tails black, white-tipped; discal spot on fore wings of male small,

oblong obovate, the inner end bluntly pointed, nearly three times as long as broad, blackish gray, edged narrowly and inconspicuously with black. Subcostal nervule on either side of the cross vein closing the cell curved a little downward, though not so much as in the other species of the genus; upper cross vein closing the cell nearly transverse, and in continuation of the lower. Fore wings scarcely so broad as in the other species; outer margin of the hind wings regularly curved, its longer tail scarcely longer than the breadth of an interspace, the shorter very slight.

Beneath uniform lustrous, rather dark pearl gray, with a faint lavender reflection—paler gray and without the lavender reflection in old specimens. Extremity of the cell of the *fore wings* marked by a transverse, straight, narrow black streak, usually longest above, entirely and narrowly encircled with white; midway between this and the outer border and subparallel to the latter is a series of eight small roundish black spots encircled with white, one in each interspace above the lowest; the upper four are placed in a slight curve, the arc of a circle whose centre is at the base of the wing; the fourth to the eighth form a nearly straight series, parallel to the outer border, the fifth a little within the line; the fifth and sixth are the largest, the first smallest and the rest nearly equal, about one-fourth the size of the eye; the seventh and the eighth are approximated, their white edging confluent. Beyond this band is a submarginal series of not very prominent orange lunules, often obsolete, excepting in the median interspaces, surmounted by blackish and these by white scales, the whole parallel to the outer border. The space between this and the border is often more or less infuscated and the outer margin is narrowly edged with black, surmounted in the median and submedian areas by a slender white line, sometimes continued as a pale inconspicuous line along the whole outer margin. Extremity of the discoidal cell of the *hind wings* bordered as in the fore wings, but, necessarily, with a longer streak; there is also a somewhat similar series of roundish spots and streaks, encircled with white; the upper four are placed in an arc whose centre is on the inner border, next the middle of the abdomen; the fifth and sixth lie on a line with the first, parallel to the discoidal streak; the seventh consists of a subreniform spot, toward which the discoidal streak points and the direction of which it frequently shows; the last is a long and slender, curving or bent streak, in the lowest interspace, having a direction nearly at right angles with the general course of the lower portion of the series and extending toward the base farther than the tip of the abdomen; the roundish spots of this series are nearly equal in size, the first a very little the largest; usually they are very little larger than the spots of the fore wings. There is a submarginal series of orange lunules varying greatly in size, confluent on the lower half of the wing, each surmounted by a black line, almost sagittate, edged with white, and followed by dusky spots, giving place in the lower median and lowest interspaces to small, blackish, triangular spots and, in the medio-submedian interspace, to a very large dusky spot, profusely sprinkled with caerulean, which almost divides the otherwise entirely confluent orange spots; outer border delicately edged with black, surmounted by a slender line of white scales; fringe and tails much as above.

Abdomen above like the upper surface of the wings, the tip and sides grayish, beneath white, edged with grayish; alations of upper organ of male (34: 16) well rounded, but slightly angled at the upper distal edge, the lower edge produced to a triangular lobe, overlapping the clasp; the latter straight and nearly equal beyond the slightly gibbous base, with which the apical portion is bent at a slight angle.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of stigma of ♂ 1.6-2.2.						
Length of fore wings.....	12.75	15.	16.	15.	16.	16.5
antennae.....	6.75	7.25	7.8	7.	7.5	7.7
hind tibiae and tarsi.....	4.	4.5	4.5	4.5	4.5	5.25
fore tibiae and tarsi.....	2.5	3.2	3.5	3.5	3.7	3.35*

Described from 13 ♂ 6 ♀. Length of longe. tails ♂ 2.2-2.75; ♀ 2.3-2.5

*Both fore legs of this individual were of from some cause; they should have been the same length; they must have been stunted at least one-fifth longer.

Secondary sexual distinctions. See description of fore wing for appearance of the stigma. The scales of the same (46: 21) very closely resemble those of *T. calanus*, being less than four times as long as broad, subequal, broadly rounded at the tip, but with the sides of the base slightly lobed.

Egg (65: 1). Closely resembling that of *T. calanus*, but scarcely so high, and with somewhat deeper micropyllic pit; prominences slender, tapering, truncate, much farther apart than their own height, uniform in elevation, about .015 mm. thick at tip; the cells are subcircular, averaging .04 mm. in diameter, reckoning from the centre of the walls; the micropyle pit is .065 mm. in diameter. Height of egg, .4 mm.; breadth, .72 mm.

Caterpillar. Last stage (75: 16-18). Head (79: 25) shining, very pale greenish brown, the lower half of the triangle fuscous; antennae with the basal joint white, the apical reddish; ocelli white in a blackish field; labrum and mandibles reddish brown.

Body grass green, deepest on the dorsal area, more or less distinctly marked with whitish. First thoracic segment with two faint, pale greenish laterodorsal lines and on either side two oblique lines, inclined from above backward and downward, the upper as indistinct as the laterodorsal line, the lower tinged with yellow; behind this segment the body is similarly marked; there is a pair of very distinct laterodorsal white lines, approximating a little at the anterior extremity but otherwise parallel, extending distinctly as far as the end of the seventh abdominal segment and indistinctly to the tip of the body; there is a distinct lemon yellow, sometimes whitish, infrastigmatal line, commencing with the distinct band of the first thoracic segment and extending to the tip of the body; on the sides of the body between these two lines there are on each segment two fainter, narrower, oblique, whitish lines, the lower in broken continuation with the upper of the preceding segment; beneath uniform green; hairs white or colorless, straight or slightly curved, the longer two or three times longer than the shorter, those of the first thoracic segment brownish. Spiracles pale brownish encircled with pale. Legs very pale greenish, the claws fuscous at tip; prolegs green, their apices colorless. Length, 16 mm.; breadth, 4 mm.; height, 3.75 mm.; length of lateral hairs .28-.44 mm.; length of other hairs, .16 mm.; of apical bristle of antennae, .2 mm.

In younger specimens the lateral oblique stripes are obscure and in the oldest ones there are sometimes three instead of two on a segment.

Chrysalis (84: 85). Upper surface dull yellowish brown, obfuscated with blackish brown spots which are scattered over the whole surface, collected into obscure dusky stripes on the sides of the abdominal segments, which curve around behind the spiracles, and are wanting along the narrow obscurely yellow subdorsal lines; a black dorsal line on the thorax and a dusky dorsal stripe on the abdomen. Under surface and wings greenish plumbeous, dotted abundantly with blackish spots, the posterior border more or less obscured; the network of interlacing ridges is composed of rather larger cells than in most of the other species, covering most of the body, as distinct on the sides as on the back, and is furnished at all points of intersection with little warts; the hairs are pretty abundant, moderately long, about one-half as long again in front as on the sides, bluntly rounded at tip, their spicules at the most not more than one-third of the diameter of the spine in length, and directed considerably forward so as to give the sides of the spine a sharply serrate appearance. Hairs erect on the thorax, somewhat recumbent on the abdomen; thoracic spiracle white, others yellowish brown. Length, 10.5 mm.; breadth, 4.5 mm.; height, 4.5 mm.; height of hairs on front, .28 mm.; on sides, .2 mm.

Distribution (24: 4). This butterfly apparently occurs in the east only in the vicinity of the boundary line of the Canadian and Alleghanian faunas, but principally in the latter, in a narrow belt stretching from the Atlantic to Montana. But it also occurs in a hardly distinguishable

form on the Pacific coast from Vancouver's Island to southern California, Nevada and Arizona; and I have seen in the British Museum specimens from Nicaragua which to all appearance also belong here.* On the eastern side of the continent it has been found in Montana and Dacotah by Morrison, Iowa (Parker), Wisconsin "common" (Hoy), northern Illinois (Worthington), Michigan (Mus. Mich. Univ.), London, Ont. (Saunders—to whose indefatigable researches our principal knowledge of the insect is due), Ottawa (Billings), Montreal "very rare" (Lyman), Bethlehem and Albany, N. Y. (Lintner) and Philadelphia (Blake, Edwards).

In New England it is rather widely distributed, having been found in Montpelier, Vt. (Minot), Milford "very rare" (Whitney) and Nashua, N. H. (Harr. Coll.), Williamstown and Cape Cod, Mass. (Seudder) and Farmington, Conn. (Norton).

Haunts. The butterfly occurs in wet places where willows abound (Saunders); my specimens were taken about thickets fringing streams.

Food plant and habits of caterpillar. The larvae feed on different species of willow (*Salix*), eating the leaves from the edge inward. They are very supple in their movements, their body curving like that of a snail, as they pass from one leaf to another or from the upper to the under surface. They move slowly, and if kept in too close confinement are subject to a species of diarrhoea which often proves fatal. At such a time one refuses food, grows pallid and shrunken, and at its worst stands in an arching posture thrusting out and withdrawing the head. When thus stretched the front half of the body becomes flattened and the hinder half swollen while the head is sometimes so far advanced as to disclose a long neck, the mouth sometimes on the ground, sometimes curved over inwards so as almost to touch the prolegs. This is accompanied by muscular contractions of various parts of the body and spasmodic movements of the legs and prolegs, the creature meanwhile standing, as it were, on tiptoe.

Pupation. The day before the first preparation for pupation, the caterpillar takes on a decidedly purplish tinge, and, by the time the girth is made, it becomes a purplish roseate, the oblique stripes a little paler and the subdorsal and infrastigmatal lines still paler. In twenty-four hours the body becomes much shorter and thicker, the back quite regularly arched behind the first thoracic segment and the sides regularly rounded. It measures at such a time 11 mm. long, 5.25 mm. broad and 4 mm. high. The girth passes considerably forward and crosses the middle of the second thoracic segment. It is about three days after the spinning of the girth that the final change occurs. First, the form of the chrysalis can be detected beneath the larval skin, the separation of the thorax and abdomen being evident; then the skin splits and apparently is withdrawn by the shrinkage of the membrane alone, which frequently remains covering

* I do not find these noticed in Godman and Salvin's *Biologia centrali-americana*.

a part of the abdomen, but generally collects as a shrivelled lump at the tail. At the close, the girth is found passing over the second abdominal segment.

Life history. The butterfly generally appears about the 10-15 July, although it sometimes occurs as early as the very end of June; it remains upon the wing until the end of the first week in August—perhaps longer; the eggs are doubtless laid during the last of July and remain unhatched until spring; the caterpillars become fully grown in the latter part of June, and according to Mr. Saunders remain eight or nine days in chrysalis; my own observations upon this point were not so carefully noted as they should have been, but I think specimens received from Mr. Saunders remained nearly fourteen days in the pupa.

Desiderata. The distribution of this butterfly needs particular attention; the time and place of the deposition, the season of hatching of the eggs and the duration of the chrysalis state are points which need investigation. We require also a description of the earlier stages of the larva and notices of the flight, habits and posture of the butterfly. No parasites are known. Has the larva any other food than willow?

LIST OF ILLUSTRATIONS.—*THECLA ACADICA*.

<i>General.</i>		<i>Chrysalis.</i>	
Pl. 24, fig. 4.	Distribution in North America.	Pl. 84, fig. 35.	Side view.
<i>Egg.</i>		<i>Imago.</i>	
Pl. 65, fig. 1.	Side view.	Pl. 6, fig. 13.	Male, both surfaces.
<i>Caterpillar.</i>		34: 16.	Male abdominal appendages.
Pl. 75, fig. 16, 17.	Dorsal views.	46: 21.	Androconium.
18.	Partly dorsal, partly lateral view.		
79: 25.	Front view of head, stage v.		

TRIBE LYCAENIDI.

BLUES.

Papiliones polyophtalmi Wien. Verz.
Clives (pars) Herbst.
Adolescentes Hübner.

Lycaenides Kirby; *Lycaeninae* (pars) Butler;
Lycaenidae (pars) Guenée.
Cupidilli Scudder.

Hued like a rainbow, sparkling as a dewdrop,
Glittering as gold, and lively as a swallow,
Each left his grave shroud, and in rapture winged him
Up to the heavens.

ANON.

Frail feeble sprites!—the children of a dream!

Like motes dependent on the sunny beam,
Living but in the sun's indulgent ken,
And when that light withdraws, withdrawing then.

Hoon.—*Plea of the Midsummer Fairies.*

Imago. Colors above principally violet; club of antennae usually equal throughout most of its extent, long and slender, being about three times as broad as the stalk and from four to five times longer than broad. Patagia long and slender, usually about two and a half times longer than broad; subcostal nervure of fore wings with three

superior branches; the outermost forked, the nervure itself running in a very direct course to just below the tip of the wing; androconia battledore-shaped, linearly beaded; tarsi armed beneath with only two or three rows of slender spines; fore tarsi of male armed at tip with a single median claw, broad at base and rapidly tapering, scarcely curved. Upper organ of male abdominal appendages furnished not with broad alations but with gibbous expansions, bearing backward or downward directed laminae or hooks; clasp broad at the base and tapering more or less irregularly to a blunt or sharp point; intromittent organ not so long as in *Theclidi*, but of similar shape.

Egg. Tiarate, almost equally truncate above and below, regularly studded on the sides with stout, rounded prominences connected by a much thinner tracery of lower lines, forming cells of a size proportionally greater than in *Theclidi*. Micropyllic pit comparatively shallow, minute, with sloping walls.

Caterpillar at birth. Head barely narrower than the first thoracic segment. Dorsal hairs arranged in a laterodorsal series, a long and a short hair to a segment in each row; substigmatal series with three bristles to a segment.

Mature caterpillar. Body scarcely broader, proportionally, than in *Chrysophanidi*, but more so than in *Theclidi*; posterior portions of segments slightly elevated; body covered with raised, six-rayed, papillate dots, each giving rise to a very short hair, those at the extremities of the body and on the substigmatal fold twice as long as the others.

Chrysalis. Body very variable in proportions, but longer than in *Theclidi* in comparison with its height, and especially with a relatively longer abdomen; dermal appendages consisting of cylindrical hairs, which are uniformly tapering, provided abundantly with minute spicules, which diverge from the stem at nearly right angles.

This tribe of Lycaeninae, commonly known as Blues, are, like the violets and hepaticas they resemble, the harbingers of spring; some of them are among the earliest butterflies to escape from the chrysalis, and are preceded only by those *Nymphalidae* which hibernate in the perfect state; they are accompanied by their allies, the *Incisaliae*, and by some sombre species of *Thanaos*, almost the only early *Hesperians*; like the latter, they frequent thickets and usually are seen only by persons who seek them. They are most attractive butterflies, with their delicately tinted wings of various azure hues, their spasmodic flight and playful pugnacity. They may readily be distinguished from other Lycaeninae by their slither bodies and generally more slender structure and by the cerulean tints of their upper surface: beneath, the hind wings are usually supplied with small and numerous, ocellated spots and are almost never furnished with tails, there being but a single exception among the European and North American genera. Broad color distinctions on the upper side of the wings are very common between the sexes, principally in the replacement of blue areas by brown; and consequently, no doubt, hermaphroditism has been more commonly recognized here than would otherwise be the case. The tribe is remarkable for the structure of the androconia or scales peculiar to the male sex, which in no other group of butterflies are battledore-shaped, with beaded markings linearly arranged.

Speyer has noticed (*Isis*, 1843, 175-6) that the fore and middle tibinae of many European species of this group bear at the tip, above, a horny bristle of variable length, extending over the basal tarsal joint; and he

further remarks that its presence or absence sometimes separates closely related species. The European *Rusticus bellargus* and *Lycaena corydon* perhaps offer the best example of this peculiarity, which does not appear to be present in any of our New England species, although we possess a species of *Rusticus*. The tibial bristle is never present in the other tribes of *Lycaeninae*.

The *Lycaenidi* form a characteristic and important feature of the butterfly fauna of Europe and to a certain extent of western North America, especially, in both countries, in mountainous regions; but they compose an insignificant part of the fauna of the eastern part of our continent and are almost wholly unknown in South America.

We are not therefore surprised to find that not one of the genera found in New England is of peculiarly American origin, all being also represented in the Old World and on the Pacific coast; in marked contrast to what we have seen to be the case among the *Theclidi*.

The eggs are of a very depressed, echinoid shape, studded with projections connected by delicate raised lines. They are laid singly. The larvae feed upon herbaceous plants, principally upon *Leguminosae*, rather than upon trees and shrubs, as the *Theclidi*: they taper less than those of the other groups. More than any other *Lycaenidi* they are provided with an abdominal secreting vesicle and caruncles, attractive to ants which become their companions. Fuller details will be given under the species.* Westwood says "the chrysalis is generally attached to the stems of plants; but occasionally this state is passed beneath the surface of the earth." I find no repetition or verification of this latter statement; perhaps it had its origin in the fact that several European species are known to half burrow themselves in the ground for pupation, probably the better to secure their fastenings. The insects sometimes hibernate as chrysalids, but occasionally as larvae or even in the egg; never so far as known in the perfect state. Our few species are variable in this respect, and perhaps represent all these types. The number of generations is variable, some species being single, some double, and one of ours even triple brooded. In one of our species, polymorphism runs riot. On the other hand, Baker reports one instance in which pupal life in a European species continued for two years (*Ent. monthl. mag.*, xxii: 90).

Table of genera of Lycaenidi, based on the egg.

Flat or depressed portion of upper surface scarcely half the diameter of the egg.	
Egg less than half as high as broad.....	<i>Everes</i> .
Egg more than half as high as broad.....	<i>Cyaniris</i> .
Flat or depressed portion of upper surface more than half the diameter of the egg.....	<i>Rusticus</i> .
(Noliades not seen.)	

* See a summary of the species in which these two sets of organs occur, in a paper recently printed by me in the *Proc. Bost. soc. nat. hist.* xxiii: 357-358.

Table of genera, based on the caterpillar at birth.

- No lenticles in front of the laterodorsal abdominal papillae.
 Two series of lenticles on each side of body above spiracles.....**Everes**.
 Three series of lenticles on each side of body above spiracles.....**Cyaniris**.
 A series of small lenticles on the abdominal segments in front of the laterodorsal papillae.....**Rusticus**.

(Nomiades not seen.)

Table of genera, based on the mature caterpillar.

- The outer margin of the narrow dorsal area of the body marked by comparatively prominent bristles.
 Last segment of body broad and greatly depressed.....**Everes**.
 Last segment of body comparatively slender and moderately depressed.....**Cyaniris**.
 Body clothed everywhere with uniform pile, the special subdorsal bristles being lost before the final stage.
 Pile rather long, dense. Upper cleft of head rather broad.....**Nomiades**.
 Pile rather short, sparse. Upper cleft of head very narrow.....**Rusticus**.

Table of genera, based on the chrysalis.

- Front of body, as seen from above, rounded.
 Body very slender, much more than three times as long as broad.....**Everes**.
 Body rather stout, much less than three times as long as broad.....**Cyaniris**.
 Front of body, as seen from above, slightly emarginate.....**Rusticus**.
 (Nomiades not seen.)

Table of genera, based on the imago.

- First superior subcostal nervule of fore wings partly connate with the costal nervule. Hind wings tailed.....**Everes**.
 First superior subcostal nervule of fore wings free. Hind wings without tails.
 Eyes delicately pilose.
 Fore tarsi of male not more than one-sixth longer than the fore tibiae. Fore tibiae of female twice as stout as the first tarsal joint and hardly more than three-fourths the length of the femora.....**Cyaniris**.
 Fore tarsi of male a fourth longer than the fore tibiae. Fore tibiae of female not much stouter than first tarsal joint and nearly as long as the femora.....**Nomiades**.
 Eyes entirely naked.....**Rusticus**.

EVERES HÜBNER.

Everes Hübn., Verz. bek. schmettl., 69 (1816). *Type*.—*Pap. argiades* Pall.

Comme le papillon sur ses ailes poudreuses
 Porte aux gazons émus des peuplades de fleurs,
 Et leur fait des amours sans périls et sans pleurs.

DE VIGNY.

Imago (5' . 3). Head small, densely covered with scales, recumbent on the front, more erect above, and tufted slightly about the base of the antennae; provided also sparsely with longer, but still rather short, hairs, nearly erect above, curved downward in front. Front nearly flat, slightly sunken above, a very little bulbous below, barely protruding beyond the front of the eyes, twice as high as broad, scarcely two-thirds as broad as the eyes on a front view, the sides parallel, the upper border squarely docked, its angles hollowed in front of the antennae, the lower border well rounded. Vertex scarcely vaulted, with a scarcely perceptible ridge running from the middle of the hind border to the nearest point of the antennae, to which it acts as a support, and separated from the occiput by a nearly straight, rather deep groove, with walls

sloping toward each other at considerably more than a right angle, the posterior the more abrupt. Eyes not large nor full, naked in every part. Antennae inserted in the middle of the summit, separated by a space equal to the width of the basal joint; barely longer than the abdomen, composed of about thirty-two joints, of which the last twelve form a depressed, elongate club, the first three of which broaden rather rapidly, but beyond them the club remains equal or even diminishes very slightly, the bluntly conical tip composed of three or four joints; the club is three times as broad as the stalk, and about four times as long as broad. Palpi slender, compressed, tapering, less than twice as long as the eye, the apical joint three-fifths as long as the penultimate, and provided only with recumbent scales; other joints also furnished beneath with a curving fringe of very long, thick scales, all closely compressed in a vertical plane.

Patagia slender, arched longitudinally, but scarcely tumid, very small, about two and a half times longer than broad, tapering gradually and regularly, with straight sides on the basal two-thirds, beyond which they are equal, bent slightly outward, so that the whole inner margin is about straight, and bluntly pointed.

Fore wings (39:20) two-thirds as long again as broad, the costal margin very gently convex, less so beyond the base, the outer angle scarcely rounded off, the outer margin rather broadly and regularly rounded, having a general direction of about 55° - 60° with the costal margin, the inner margin straight, the angle rounded. Costal nerve terminating opposite the middle of the outer half of the cell, confluent for a part of the time with the first superior subcostal nerve; subcostal nerve with three superior branches; the first, arising scarcely beyond the middle of the upper margin of the cell, runs at first into the costal, is completely confluent with it for a short distance, and then parting from it, ends on the margin opposite the apex of the cell; second superior branch arising at about one-fourth the distance from the origin of the first to the apex of the cell; and the third at a little more than half way from the origin of the second to the apex of the cell, forking before the middle; cross veins closing the cell exceedingly faint and transverse, bent at a slight angle; cell scarcely half as long as the wing, and three and one-half times longer than broad.

Hind wings with the costal margin well curved, more strongly on the basal than the apical half, the outer border strongly rounded, very full on the upper half, and perhaps rather more so in the δ than in the ϕ , the medio-submedian interspace very slightly and roundly emarginate, the lower median nervule furnished with a very slender, thread-like tail, considerably longer than the width of the interspaces at its base; inner margin rather strongly convex near the base, beyond straightly excised, the angle abrupt but broad. Submedian nerve terminating at the anal angle; internal nerve terminating at about the middle of the inner border.

Androconia rounded quadrate, the stem less than half as long as the lamina.

Fore tibiae three-quarters the length of the hind tibiae; fore tarsi not so crowded with spines as on the other legs, scaled beneath, the tibial spurs naked and small, smaller in the male than in the female; the terminal joint is either like that of the other legs (ϕ), or it is furnished at tip with only a single, median, long, tapering, scarcely curving hook, without paronychial or pulvillus (δ). Middle tibiae a little shorter than the hind pair, provided at tip with long and slender, tapering spines, mostly concealed by large scales. First joint of tarsi as long as the others combined, the second, third and fourth diminishing regularly in size, the fifth equal to the second; the terminal joint furnished beneath with two, the other joints with three rows of moderately long and slender spines, the terminal outer ones of each joint much longer than the others, spur-like and curved; claws very small, short, gently curved, tapering but little, pointed; paronychial double, the upper piece long and very slender, tapering, almost filiform, incurved and delicately pointed, the lower piece a ciliate lobe, hardly longer than broad and rounded; pulvillus wanting.

Upper organ of male abdominal appendages forming a short, semicircular, laminate hood, the edges setose, the posterior margin entire; lateral arms slender, very long and strongly arcuate; claps forming a not very long, subequal, somewhat bellied ribbon, broadly rounded apically.

Egg. Very depressed echinoid shaped, the whole upper surface almost perfectly flat, flatter above than in *Cyaniris* and not so high for its breadth; covered with moderately prominent and not crowded tubercles, connected by fine raised lines forming subquadrate or rhomboid cells, but with no subordinate tubercles, the micropyle not sunken.

Caterpillar at birth. The head is as broad as the body or barely narrower than the first thoracic segment; frontal triangle large, more than half as high as the head, nearly as broad at base as high. Body subcylindric, scarcely tapering from in front backward, the first considerably larger than the other thoracic segments, furnished with rather shorter bristles than the rest of the body, few in number and regularly disposed. The other segments have regularly disposed appendages as follows:—a subdorsal series of high papillae and long, tapering hairs, as long as the width of the body, on the thoracic and first eight abdominal segments, a little in advance of the middle; a laterodorsal series of small papillae with shorter hairs, on the same segments, centrally situated; a laterostigmatal series of high papillae with comparatively short truncate (but not, as represented in 71: 5 clubbed) bristles, on the first six abdominal segments, two to a segment, one anterior and a little lower with slightly longer bristle, the other posterior and higher. There is also a similar but longer infralateral bristle, anteriorly placed, on the third thoracic segment; and an infrastigmatal series of long hairs three to a segment, of which one is central, on a high papilla directly on the substigmatal fold, and the others are on lower papillae, one a little lower and anterior, the third above it and posterior. There are also series of hairless lenticles or annulas as follows: a supralateral series on the thoracic and sixth to seventh abdominal segments, the former large, the latter small; a lateral series, large on the first eight abdominal segments, a small, infralateral one on the fourth abdominal segment (and on all the segments a small, suprastigmatal series and on the abdominal segments a small, infrastigmatal series; these last I have been unable to verify since my notes were made). All hairs and bristles are microscopically spiculed.

Mature caterpillar. Head hardly more than one-tenth the width of the body. Body longitudinally arched, more abruptly curved in front and behind, more strongly in front than behind, but in the middle with a narrow dorsal field and testiform sides, the incisures deeply cut. On most of the segments there is a subdorsal group of spiculiferous hairs, which in the earlier stages are subequal, long, erect and forward curving, but later are unequal, a single longer one curving outward, the shorter ones erect. The crateriform annuli of the first stage continues at least into the next; full notes were not taken. The caterpillar differs from that of *Cyaniris* in the great breadth and flatness of the last abdominal segment and in the more lateral position of the caruncles of the eighth abdominal segment.

Chrysalis. Long and slender, nearly four times as long as broad, the sides, viewed from above, parallel and straight from the base of the wings to their tip, beyond which the abdomen tapers a very little and ends in a long elliptic curve. Viewed laterally, the abdomen is highest at the third and fourth abdominal segments and is very broadly and regularly arched; and, although not high, the upper part of the ninth segment is perpendicular; transversely the abdomen is regularly rounded, forming perhaps a little more than a semicircle; three-fourths of the tongue exposed, the inner edges of the legs resting against it; basal wing prominence apparently altogether absent; surface of the abdomen transversely, coarsely and infrequently striated, particularly on the hinder part of the segments and with very distant minute warts, perhaps 15-20 on the dorsum of a single segment, giving rise to long, nearly equal, apically tapering, pretty slender hairs. Similar hairs are found all over the thorax where they are slightly longer.

The body, says Dr. Harris, is slightly contracted laterally before the middle, broadest behind the middle, more obtuse before than behind, and the thorax projects slightly above.

This genus is represented by four or five species in the northern hemi-

sphere, one in the Old World, and the others in the New, in both continents extending from ocean to ocean, thus encircling the globe; its northern limit in both worlds is about Lat. 57° ; in America it extends south to Lat. 12° N.—almost to South America,—while in Europe it only reaches Lat. 43° , and in Asia about five degrees further, to Kashmir and northern China. Besides which the genus reappears in India and the Malayan archipelago, where several species are found. The transformations of several species are known; one American form is found throughout New England.

The butterflies may be distinguished from all other indigenous *Lycænidæ* by the presence of a thread-like tail at the tip of the lowest median nervule of the hind wings; on the upper surface the wings are violet in the male, dark brown suffused on the disc with the male colors in the female. Beneath they are very pale brown with faint marginal markings over most of the outer border; these markings on the hind wings are intensified in the median interspaces forming, especially in the lower one, a blackish spot surmounted by a bright lunule: there is also an extra-mesial series of blackish spots or dashes, nearly straight on the fore wings, strongly tortuous on the hind, besides a transverse dash at the tip of the cell and on the hind wings a couple of round spots near the base.

The butterflies are polygeneitic, the paleogeon and probably the neogeon species hibernating in curled leaves as full grown caterpillars and transforming to chrysalids in May, about a fortnight before the first brood of butterflies appears. The European butterfly, according to Speyer, flies over sunny flowery spots in thickets and on mountain meadows and is mostly found in hilly regions. The American species is found quite as often on plains and river bottoms. The duration of the egg is but three or four days; the caterpillars mature rapidly and the summer chrysalids evolve their inmates more quickly than those of spring. The caterpillars feed on a variety of Leguminosæ, the European species having been found on *Lotus*, *Anthyllis*, *Medicago*, *Trifolium*, *Pisum* and *Onobrychis* and even on *Rhamnus*; while ours are known to feed on *Lespedeza*, *Phaseolus*, *Desmodium*, *Galactia*, *Trifolium* and *Astragalus*. The caterpillars of the European species are known to bore the husks and devour the peas of *Pisum*; and an entirely similar habit has been discovered in one of the Californian species by Messrs. Wright and Riley, the latter of whom writes me that *Everes amyntula* "lives within the pod of *Astragalus leucopsis*, frequently in connection with a noctuid and a curculionid larva and always leaves the pod to pupate. While it feeds normally upon the young and tender seeds, it also shows quite a carnivorous propensity and will eat its associates just mentioned when they are not too active or large."

The caterpillars are elliptical in form, flatter and more elongated than in *Cyaniris*, with a flatter terminal segment, of a greenish color, with a dark dorsal stripe and many oblique lateral lines.

The chrysalids are longer and slenderer than in *Cyaniris*, being nearly four times longer than broad, the abdomen but slightly more elevated than the thorax, and the whole body covered with long distant hairs by which they may readily be distinguished; in color they resemble the caterpillars, or are darker and spotted with black.

EXCURSUS XXXII. LENGTH OF LIFE IN BUTTERFLIES.

Viator loquitor:

"Royal in purple and gold and red,
Free, and unknowing sorrow,
Blithely and lithely to and fro,
With flowers for thy choosing still a-blow,
Flaunt through the idle noon;
But the day is short and the summer sped,
And alas for the end of joy so soon;
The days are short and the rose is dead,
And thou wilt be dying to-morrow."

Butterfly loquitor:

"Sunshine and blossoms are on my way;
What is the talk of sorrow?
Blithe on the wing with flowers for rest,
Hither and thither as likes me best:
Oh the joy of the while!
Minutes are many to bask and to play,
The earth is glad and the blue skies smile;
Minutes are many and joy is to-day;
Dying is far off to-morrow."

AUGUSTA WEBSTER.—*The Butterfly.*

AURELIANS are frequently asked how long butterflies live. By this is generally meant what is the length of life of the mature insect. As is generally known, each species passes through one cycle of its existence once a year, though it very frequently happens that two, three, or even more generations succeed one another during a single season, and it has been supposed (though never proven) to be the case with some that two or more years are required for this cycle; as is known to be true of some other insects. But with regard to the length of life of the butterfly itself, there is not a little variety: when the disappearance of a given butterfly is in consequence of the approaching cold season it may well be and often is the case that the butterfly has merely gone into winter quarters to appear again on the wing the ensuing spring. In cases like these, the duration of life of a butterfly may be as long as eight or nine months or even more, for there are hibernating butterflies which emerge from the chrysalis by the beginning of August or even in July, but which do not go into winter quarters until September, October or even November, then appear again the next season as soon as advancing spring has begun to make itself felt, and continue upon the wing sometimes through June, sometimes even into July. It is impossible to say certainly whether or not the individuals flying latest in the spring number among them any which were earliest to escape from the chrysalis in the preceding season. But setting aside the chances of capture by their enemies, there is no reason to believe it impossible, and that they may spend and probably in many instances do spend fully ten months of the year in the winged condition.

This conclusion may be reached also in another way. We may add together the ordinary life period of the egg, the time it takes the caterpil-

lar to reach maturity, and the period of the chrysalis, and in these hibernating butterflies we shall rarely find that these stages together occupy on the average more than two months. The remaining ten months must therefore be the average time spent upon the wing. That many may live eleven months or even twelve seems probable, for a butterfly may continue to fly for some time after the first eggs are laid, especially in the case of those which lay but one at a time, where the eggs do not develop in the ovaries at once, but slowly and by degrees, and so are deposited in succession over a considerable period of time.

In an article in the *Canadian Entomologist* on this subject, Mr. W. H. Edwards has labored to show that eggs are almost invariably laid by butterflies fresh from the chrysalis, and that the butterfly dies soon after the laying of the eggs. This proves quite too much, for if it were so, a butterfly would hardly fly more than a week. That eggs are often laid by butterflies soon after eclosion from the chrysalis is doubtless true, but there are quite as many cases, where egg laying is delayed for a considerable length of time,—two, three or four weeks; an examination of the ovaries of butterflies will show that it is rarely the case that all the eggs are laid even within two or three days of each other, but that they mature by degrees too slowly for such rapid oviposition. There are of course some, in which the eggs are laid in masses, when a greater number are laid in a single day, but the cases are far more numerous where egg laying is continued over many days, and sometimes probably over several weeks.

It is possible that the duration of the life of butterflies is greater in the north than in the south. As one approaches the tropics, insectivorous birds and other creatures are far more destructive of butterfly life than with us, and the chance of long life upon the wing must be greatly lessened with the numerous liabilities to disaster which overtake the poor butterfly in the warmer regions. There may even be a difference in this respect between districts so near each other as West Virginia and New England. For certainly my own experience of the overlapping of broods of different butterflies as seen by me in New England is very different from that reported by Mr. Edwards in West Virginia, and inasmuch as these broods follow each other with greater rapidity in Virginia than with us, the difference is thereby exaggerated.

To judge from the statistics that I have collected from observations made in the field both by myself and numerous correspondents, I am inclined to think that, in the case of those butterflies which are born and die the same season, the average length of life of the mass of them, that is, omitting mention of those which, cut off early, come to an untimely end, to be not far from four to five weeks, varying in different species from three to six or seven. Of course it is impossible to arrive at any very ac-

curate determination regarding this, since in the case of any particular species we are obliged to base our conclusions on observations of the times when the earliest butterflies were seen, when they became most abundant, when the numbers perceptibly diminished, or specimens became old and worn, and when the last were seen. It is particularly difficult to decide upon the average age of individuals, when, as is not infrequently the case, a brood of butterflies is augmented by gradual accretions for a long period of time, three, four or five weeks. It is again difficult in the case of those butterflies, and there are not a few of them, like some of our *Argynniidi*, which appear upon the wing in mid-summer, receive a sudden accession to their numbers a month or two after the advent of the earliest and then only begin to lay their eggs. I, for one, can hardly believe that all these earliest individuals perish before the season for egg laying, and I even think from the condition of specimens, worse and worse as the season progresses, that some of the earliest live to the last and are upon the wing sometimes for two and three months of the year.

. See a paper on the subject by W. H. Edwards (Can. ent., xiii: 205-14).

EVERES COMYNTAS.—The tailed blue.

[The least blue butterfly (Abbot): Comyntas butterfly (Harris): tailed blue (Scudder).]

Polyommatus comyntas God., Encycl. méth., ix: 608, 609 (1819);—D'Urban, Can. nat., v: 246 (1860);—Morr., Syn. Lep. N. Amer., 83 (1862);—Harr., Ins. inj. veg., 3d ed., 275 (1862); Entom. corresp., 275 (1869).

Argus comyntas Boisid.-LeC., Lep. Amér. sept., 120-121, pl. 36, figs. 5-9 (1833).

Lycaena comyntas Doubl., List Lep. Brit. mus., ii: 43-44 (1847);—Edw., Can. ent., viii: 202-205 (1876);—Middl., Rep. Ins. Ill., x: 95-96 (1881);—Fern., Butt. Me., 93-95, fig. 32 (1884);—French, Butt. east. U. S., 292-294, fig. 81 (1886);—Mayn., Butt. N. E., 40, pl. 5, figs. 50, 50a (1886).

Cupido comyntas Kirlb., Syn. catal. Lep., 356 (1871).

Plebejus comyntas Kirlb., Syn. catal. Lep., 653 (1871).

Everes comyntas Scudd., Syst. rev. Amer. butt., 35 (1872); Butt., 130, 152, 308, fig. 125 (1881).

Papilio—Abb., Draw. ins. Ga. Brit. Mus., xvi: 58, tab. 242 (ca. 1800).

Figured also by Abbot, Draw. ins. Ga., Oemler coll., Bost. soc. nat. hist. 16;—Glover, Ill. N. A. Lep., pl. 2, fig. 3; pl. 9, fig. 11; pl. 20, fig. 3; pl. 27, figs. 6, 9, 10; pl. 28, figs. 9, 11; pl. F, fig. 7, lined.

... Sylphe aérien, si splendide, et si leste,
Qui semblait voltiger en vingt lieux à la fois.

POMMER.—*Le Papillon-Esprit*.

Mine eyes have drawn thy shape, ...
Yet eyes this cunning want to grace their art;
They draw but what they see, know not the heart.

SHAKESPEARE.—*Sonnet*.

Imago (6: 9, 10; 14: 2). Head covered with black scales with a distinct border of white around the whole eye excepting next the antennae and just behind them; the edging, however, is carried along the inner side of the antennae and there are a very few white scales on the outer portion of the basal antennal joint; lower half of the sides wholly white; basal and middle joint of the palpi white, the latter wholly blackish brown above and on the apical fourth of the outer side; apical joint blackish brown,

the under surface and the tip white; antennae blackish, annulated at the base of each joint with white, much the broadest on the under inner surface where it often stretches over fully half of the joint; club above blackish brown, often with a purplish tinge, the apical three or four joints dirty white; below dull brownish yellow, ashy toward the base and sometimes along the middle line. Tongue pale dirty luteous.

Thorax covered above with blackish brown hairs, overlaid profusely with hoary blue hairs (δ) or more sparingly with pale brown hairs (φ). The shoulder covers with blackish brown scales edged, especially externally, with pale scales and, in the δ , overlaid by bluish hairs; beneath white with a faint grayish yellow wash; legs silvery white, scarcely speckled with blackish, the base of the tarsal joints heavily marked above with blackish brown, least so on the basal joint. Tip of the spurs reddish; spines black, claws bright testaceous.

Wings above either of a dark lustrous purplish violet, the outer border of fore wings to the width of an interspace, but generally with its interior limit ill-defined and the costal margin of the hind wings rich dark brown, the nervules, especially in the outer half of both wings, more or less dusky and increasingly so toward the border (δ); or nearly uniform rich dark lustrous brown, the middle of the wings with an indistinct ruddy hue (φ). *Fore wings* with the costal edge white, the tip of the cell marked transversely with an obscure brownish dash, indistinct of course in the φ . Fringe with the basal half dark brown, more distinctly so along the outer half of the base, mixed with white next the base, the outer half silvery white. *Hind wings*; the outer margin in the δ often has a dark border as in the fore wings, and in both sexes has also in general the following markings, which are sometimes partially or wholly obsolete: in each of the median interspaces a round black spot, often margined externally with blue, and separated from the outer border by only a narrow black space and surmounted by a large orange lunule; in the medio-submedian interspace a transverse black spot similarly situated, margined exteriorly, and sometimes interiorly, but often faintly, with a line of blue atoms; black spots similar to those of the median interspaces also often occur in the lower subcostal and subcosto-median interspaces, but, if margined at all, only with blue; the tail is black with a white fringe. Fringe white with a pale dusky line before the middle; at the nervure tips dusky on the basal half.

Beneath nearly uniform pale steel or satin gray, a shade duskiest toward the apex of the fore wings and paler next the inner border of hind wings. *Fore wings* with a slender, transverse, slightly curving, dark brown streak at the tip of the cell, margined narrowly with white; midway between this and the outer border is a transverse row of six dark brown spots also encircled narrowly with white, subparallel to the outer border, one in the medio-submedian interspace, and one in each of the five succeeding interspaces above it; those in the lower subcostal and subcosto-median interspaces are removed farther outward than the others by their own width; the upper ones are transversely oval; that in the lower median interspace subrescentiform, a little diagonal, the lowest transversely linear; the outer margin is narrowly dark brown, followed inwardly by an equally narrow but obscure edging of pale or dull white, most distinct in the interspaces; this again is followed by pretty large, transverse, oval, cloudy spots, and these at a slight distance, or at about an interspace's distance from the margin, by a similar series of darker curved bars, opening outwards, more distinct and broader below. Fringe white with a dusky line through the middle. *Hind wings* with a small round black spot encircled with pale in the middle of the costo-subcostal interspace, just beyond the first divarication of the subcostal, and another in the middle of the lower half of the cell, just beyond the first divarication of the median; the outer limit of the cell is marked by a line of pale brown scales, edged with pale, and there is an irregular extra-mesial row of roundish or transverse oval, blackish or blackish brown spots encircled with whitish; one is found in the costo-subcostal interspace midway between the spot formerly mentioned and the outer border of the middle of the interspace; a second just below it in the succeeding interspace; the next two are nearer the margin, one below the other in the lower subcostal and subcosto-median interspaces, being more than midway from the tip of the cell to the outer border; one in the

lower median is in broken continuation of the streak at apex of the cell, and that in the internal interspace is directly below it; while that of the upper median and the double one of the medio-submedian are parallel to them and midway between them and a parallel line drawn from the spot in the subcosto-median interspace; there is also a small blackish spot on the inner border, midway between the base and the spot in the internal interspace; the outer border is edged with blackish as in the fore wing, darkest below and followed as there by a paler space; next follows a transverse series of variable character; in the subcostal and subcosto-median interspaces are transversely suboval blackish brown spots; in the median interspaces are roundish velvety black spots, edged with glistening pale blue or opalescent scales, particularly within; in the medio-submedian interspace is a thread of black scales occasionally enlivened with opalescent; following this series but removed slightly from it, excepting in the median interspaces, is a series of spots, above the median interspaces, similar to those of the submarginal row, excepting that the one in the subcosto-median interspace is frequently tinged with orange; in the median interspaces they are large and very broad, deep orange crescents capping the opalescent rim of the black spots, and themselves edged within to a greater or less extent with black scales; in the medio-submedian is a transverse, broken black line sometimes enlarging to a spot, enlivened by some dull orange scales; tail white with white fringe. Fringe as in fore wings.

Abdomen above blackish brown with a few bluish hairs near the base; below white. Upper organ of male appendages (34: 26, 27) very short the sides produced triangularly behind and curved downward, the lateral arms very slender and strongly recurved.

Measurements in millimetres. Length of tongue, 6 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	9.5	13.25	15.25	10.	12.5	15.
antennae.....	4.75	6.	7.25	4.5	5.75	7.
hind tibiae and tarsi..	2.25	3.6	3.8	2.5	3.35	3.75
fore tibiae and tarsi..	1.75	2.3	2.8	1.8	2.35	2.5

Accessory sexual peculiarities. Scattered upon the upper surface of the wings, apparently with no regularity nor selection of place, are androconia of the normal battledore shape (46: 31), the lamina with equal sides, broadly rounded apex, scarcely longer than broad and studded with about fifteen closely crowded rows of bead-like dots arranged longitudinally and regularly; stem less than half as long as the lamina, expanding gradually as it joins it. They are much smaller than the ordinary scales, averaging about .008 mm. in breadth.

Egg (65: 20). Surface covered uniformly both above and on the sides with raised rounded bulbous points, higher on the sides than on top, arranged in tolerably regular oblique rows, and averaging .04 mm. in distance apart; these are connected by fine raised ridges of much less elevation forming tolerably regular cells, the surface of which is delicately punctate. Color delicate pea green, the elevated portions white. Toward the micropyle (68: 5, 12) the tubercles become smaller and closer and are more irregularly placed and the cells of course become smaller and often pentagonal. The micropylar space is sharply bounded by an angulate periphery, is about .01 mm. in diameter, greenish in color, with a tracery similar to that of the neighboring parts but still smaller and more delicate, the cells averaging about .01 mm. in diameter, and only the outer ones punctate. Diameter of egg .5 mm.; height .22 mm.; height of tubercles .02 mm.

Caterpillar. First stage. Head (79: 36) black, nearly as broad as body. Body pale green, subcylindrical, nearly equal. Legs luteous. Length, .75 mm.

Third stage. Head (79: 37) piceous, deeply and narrowly cleft at the crown, smooth with a very few rather long and extremely delicate hairs. Body rusty brown in short longitudinal patches, edged with pallid yellow, with a darker dorsal stripe outwardly edged with dull, pallid yellow; the lower portion of the sides with a series of darker oblique stripes forming a broken suprastigmatal series; annuli dusky; hairs pellucid;

spiracles luteous, with a narrow, fuscous ring. Legs and prolegs pallid green. Length, 3 mm.; breadth of head, .35 mm.

Fourth stage. Head piceous. Body pale green with a darker green dorsal stripe, broadest on the thoracic segments, somewhat pallid subdorsal ridges and the sides tinged with griseous from the numerous dusky ringed annuli and papillae. Caruncles of eighth abdominal segment (first noticed in third stage) pallid, the spicules orange or pale salmon; when at rest they are not wholly withdrawn but look like fleshy cups with corrugated edges and are a little more than .1 mm. in diameter; midway between spiracles of same segment is a long, erect, tapering, straight, spiculiferous, needle-like spine of a dusky color and about as long as the longest hairs. There is also a broad, transverse cleft between the spiracles of the seventh abdominal segment, occupying at least a third of the space between the spiracles.

Last stage (75: 37, 44). Head (79: 38) piceous; labrum pallid at base, beyond dark castaneous; antennae pale; ocelli black; mouth parts pale green. Body dark green, with a fuscous dorsal stripe, from the second thoracic segment backward, enforced by black points, especially near the edges of the segments. Whole of first thoracic segment infuscated. Sides of the abdominal segments between the spiracles and the pallid green infrastigmatal fold dull vinous, becoming brownish posteriorly; sides above spiracles marked with a couple of bands of short, pale brownish fuscous lunules separated from each other by their own width, the convexity upward, each upper lunule of one segment also forming with the lower lunule of the next succeeding segment an interrupted oblique line alternating with a series of oblique pale lines. Whole body, between the stigmata and the dorsal stripe and especially at the edges of the latter, besprinkled with pallid stellate papillae, each bearing a short brown spiculiferous hair, and with black, stellate, papillate points bearing a shorter brown spiculiferous hair. Legs green, with long castaneous claw; prolegs green. Length, 7.5 mm.; breadth, 2.5 mm.

Chrysalis (84: 42, 47, 49). Pale green, the abdomen brownish yellow, the thorax and wings distantly and minutely spotted with blackish fuscous; wings with about three narrow, longitudinal, blackish bands, oblique with respect to the body, extending from below upward and backward; a blackish dorsal stripe interrupted on the abdominal segments; a suprastigmatal series of rather short, oblique, blackish dashes on the abdominal segments, and a longitudinal dash in its continuation on the meta-thorax; hairs white, the spicules blackish; spiracles luteous. Length, 7.25 mm.; breadth at abdomen, 1.75 mm.; length of thoracic hairs, .6 mm.; length of abdominal hairs, .5 mm.; height at abdomen, 1.5 mm.

Distribution (24: 5). This thread-tailed and smallest of New England blues is the most widely distributed, not only occupying the full extent of our Alleghanian and Carolinian faunas, but occurring both north and south of them and extending from the Atlantic to the Rocky Mountains and in the north to the Pacific. It has been found as far north as "arctic America" [Great Slave Lake?] (R. B. Ross, Brit. Mus.), Devil's Portage, Liard River, Lat. 59° 25' N., Long. 126° 10' W. (McConnell) and the mouth of the Saskatchewan River (Seudder), although the only other points north of the United States from which it is reported are nearer the boundary, such as Dufferin and Woody Mountain (Dawson), London, Ont., where it is "not very common" (Saunders), Ottawa, a single specimen (Fletcher), Chateauguay Basin (Jack), and Montreal rare (D'Urban, Lyman). Southward it occurs not only as far as the Gulf of Mexico—Apalachicola, Fla. (Chapman), Alabama (Gosse), but even in Central America—Nicaragua and Honduras (Brit. Mus.), south-

ern Mexico, Guatemala and Costa Rica (Godman and Salvin). Westward it extends in abundance to the central part of the continent,—Wisconsin (Chamberlin, Hoy), Iowa (Allen, Austin, Osborn, Parker), Missouri (Mich. Univ. Mus.), Kansas (Snow), Colorado occasional (Mead), Fort Niobrara Nebr. (Carpenter), Dakota and Montana (Edwards) and even to British Columbia and California (Mead). This latter point escaped my notice when the map was prepared.

It is found throughout New England—even in the White Mountain district—and is everywhere a common insect, especially in the southern half.

Haunts. The butterfly frequents the roadside or overgrown pasture-tracks in the vicinity of woods. Dr. Harris observed it in dry woods and pastures frequently alighting on flowers of *Hedysarum* or *Lespedeza*. In Iowa Mr. Allen found it "on low ground and about pools of water after shower; also at the edges of groves by river banks."

Oviposition. Late one July, while plucking a *Desmodium* flower in the Botanic Garden at Cambridge, I startled one of these butterflies on a neighboring flower. It immediately returned after a short flight, alighted on the stalk I held in my hand and under my very eyes laid an egg on one of the green buds beyond the blue flowers, tucking it into the crevice between two adjoining seed vessels. Others, enclosed on *Lespedeza*, laid eggs high up on the stems, sometimes but rarely on the upper surfaces of the leaves, sometimes on the stalk itself, but generally either on one side of the base of the leaf-stalks or tucked in between the flower buds in some crevice or in the axils of the leaves. Mr. Edwards says they lay "on clover, blossoms and leaves." He also obtained eggs from confined females which were "laid on the tender terminal leaves" of *Desmodium* and "deposited on the young leaves and on the flowerets of the head of clover." The eggs hatch in from three and a half to four days.

Food plants. The caterpillar feeds upon various leguminous plants, especially *Lespedeza capitata*, *Phaseolus perennis*, *Desmodium marylandicum*, species of *Galactia* and clover. It is also said to feed on red-root (Abbot) and rag-weed (Aaron) whatever they may be. I do not find any leguminous plants answering to these names.

Habits of the caterpillar. Harris states that the larva lives solitary, in the heads of *Lespedeza*. This I have found to be the case, the caterpillar preferring the heads even when they are mature and have little succulence. On clover Mr. Edwards found the tender leaves

rapidly eaten by the very young larvae, a single larva eating out [from the upper surface] two or three furrows, the width of its body and side by side. As they became larger they seemed to feed on the calyxes of the flowerets exclusively, curving themselves to the surface of the clover head, or burrowing into it. On *Desmodium*, as there were no flowers in bloom, only the tender leaves and immature flower buds were eaten.

A caterpillar feeding on a plant flourishing well in water wished to change to chrysalis and early on August 25 took up position on the upper surface of a leaf. The next day, noticing it had kept the same position but seemed a little less visible than before, I observed that it had woven together two overhanging leaves with a web of silk, so as entirely to conceal it from view above. On August 27 A. M. it had spun a loose band across its body and noticing that the overhanging leaves seemed now still a little nearer I discovered that the tip of one was attached by a few very slight long threads at considerable distance from each other to the leaf on which it itself rested. The head of the larva is completely concealed while it is resting for the change to occur.

Life history. It is triple brooded; the first butterflies appear from the sixth to the tenth of May and the brood usually becomes abundant in five or six days and continues plenty throughout the month; by the middle of June, sometimes by the end of the first week it has disappeared. The eggs are doubtless laid toward the end of May and early in June; they hatch in a few days, the caterpillar grows rapidly and the chrysalis continues but a short time,* for the second generation usually makes its appearance between the sixth and ninth of July, occasionally as early as the fourth and sometimes as late as the twelfth or fifteenth; it is abundant in the latter half of the month but afterwards becomes rare, although fresh specimens may often be obtained the last of July and even very early in August and a few specimens continue on the wing until the third generation makes its appearance. The eggs of this brood are laid principally in the latter half of July, those obtained by me being laid July 14 to 19 and 31; the caterpillars, maturing rapidly, attain their growth during the second week in August and after nine to eleven days spent in the chrysalis (Harris) the third generation appears, about the nineteenth or twentieth of the month, though sometimes as early as the fifteenth, and remains on the wing until at least the end of the third week of September; this brood must lay its eggs early in September, giving the caterpillar time to attain its full growth before winter and to hibernate in this condition (which analogy with its European and Californian representatives renders wholly probable), remaining unchanged until about a fortnight before the appearance of the butterfly in the spring. The European species, however, is only double brooded and its history may differ from ours in other respects.

In the north, as among the White Mountains, our butterfly, too, can have but two broods, since specimens found just before the middle of July—the remnants of the first brood—were all worn. The number of broods in the southern states is unknown, but is very likely more than three, for the first generation appears as early as April 12th (Chapman) and the second about

* In the south but eight days, according to Abbot.

June 24 (Abbot). Gosse mentions the insect on August 25 in Alabama, and I have seen rubbed specimens from Georgia taken the last of October (Oemler). Edwards says that in West Virginia "there must be several successive broods, as fresh individuals are seen every month from April to September." The date (March 20, 1825) given by Harris for the time of this insect in Massachusetts is evidently an error.

Behavior of the butterfly. The flight of the butterfly is quick and nervous and it is itself so small and delicate that one easily loses sight of it as it doubles in and out among the herbage, over the tops of which—unless very low—it is rarely seen. Its flights are of short duration and it alights frequently after some seconds of uncertain quivering on the heads or terminal leaves of plants and low shrubs and vines, especially of Leguminosae. Dr. Minot observed it when alighted, holding its wings perpendicularly or parted at an angle of about 15° , rub the hind wings up and down while the fore wings were motionless.

Variation and dimorphism. It is not surprising that a polygeneitic insect with so wide a distribution should be found very variable, but as yet no differences have been pointed out in successive broods as has been done with its European congener. In Western examples the whole upper surface of the wings has a hoary aspect, and the dark spots of the under surface are remarkably faint. Southern examples differ in the lesser depth of the purplish tint of the upper surface of the wings in the male, the narrower dark bordering of the same, and in the purer and more uniform satin-gray of the under surface of the wings in both sexes. The great disparity in the size of different individuals to which Mr. Edwards has called attention is marked, because there seems to be no regular gradation between the two, but two distinct sets in size. Mr. Edwards thinks these differences appear wherever *comyntas* occurs, but the only marked cases I have noted came from Long Island and Cape Cod, and I have thought them confined to the autumn brood. Mr. Edwards calls attention to the fact that in West Virginia the female is dimorphic, "most of this sex here being black, the others blue with broad black margins." The same is the case, rarely, in Long Island, but I have not seen it elsewhere.

Desiderata. It can hardly be doubted that this variable insect is one of those whose successive generations present a different aspect, as is the case with its European congener; observations should be directed toward this point; the dimorphism of the female indicated by Edwards should be looked into and its range in time and space studied; so, too, the meaning and nature of the great disparity in size often found should be enquired into, the duration of the different stages of each generation investigated, and the condition in which it passes the winter determined. We have but imperfect knowledge of the food of the larva, as may be judged by compar-

ing the list of known food plants of the American and European species; finally, the flight and attitudes of the butterfly should be more fully studied and parasites of both egg and larva should be discovered.

LIST OF ILLUSTRATIONS.—EVERES COMYTAS.

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| <p><i>Egg.</i>
Pl. 65, fig. 20. Oblique view.
68: 5, 12. Micropyle.</p> <p><i>Caterpillar.</i>
Pl. 71, fig. 5. Caterpillar at birth.
75: 37, 44. Mature caterpillars.
79: 36-38. Front views of head, stages I, III, V.</p> <p><i>Chrysalis.</i>
Pl. 81, fig. 42, 48. Side views.
47. Enlarged.</p> | <p><i>Imago.</i>
Pl. 6, fig. 9. Male, both surfaces; colored.
10. Female, upper surface; colored.
14: 2. Male, both surfaces; plain.
34: 26, 27. Male abdominal appendages.
39: 20. Neuration.
46: 31. Androconium.
55: 3. Side view with head and appendages enlarged, and details of leg structure.</p> <p><i>General.</i>
Pl. 24, fig. 5. Distribution in North America.</p> |
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CYANIRIS DALMAN.

Cyaniris Dalm., Vetensk. acad. handl., xxxvii: 63, 94 (1816). *Type*.—*Pap. argyolus* Linn.

In their own bright Kathaian bowers,
Sparkle such rainbow butterflies,
That they might fancy the rich flowers,
That round them in the sun lay sighing,
Had been by magic all set flying!

MOORE.—*Lalla Rookh*.

That come before the swallow darts, and take
The winds of March with beauty; violets, dim.

SHAKESPEARE.—*Winter's Tale*.

Imago (55: 5). Head (61: 12) small, densely clothed with scales, which are tufted about the base of the antennae, and provided with a considerable mass of long erect hairs, longest and most abundant in the middle of the front. Front very gently curved transversely, very slightly fullest below; from a little above the middle, downward, barely surpassing the front of the eyes, not so elevated above, but vaguely grooved longitudinally; scarcely twice as high as broad, as broad as the front view of the eyes; sides parallel, upper border squarely excised, its angles slightly hollowed in front of the antennae; lower border strongly rounded. Vertex not vaulted, but with a slight, low tubercle on either side, midway between the antennae and the middle of the hind border, abruptly elevated behind the antennae, forming a transverse ridge for their support; separated from the occiput by a rather deep, slightly curving groove, its middle curving forward, the sides forming a right angle with each other, the anterior slope of the groove the more abrupt. Eyes not very large, moderately full, delicately and distantly pilose on the lower two-thirds with very short hairs, increasing in length downward. Antennae inserted in the middle of the summit, separated by a space equal to the width of the antennal pits, slightly longer than the abdomen, composed of about thirty-four joints of which the last twelve or thirteen form a club similar in all respects to that of *Everes*, excepting that the tip is more broadly rounded. Palpi slender, scarcely more than half as long again as the eye, the apical joint very nearly half as long as the penultimate, the whole under surface, and particularly that of the basal and middle joints, furnished with a mass of long, erect, delicate hairs, as long as the apical joint, which become shorter apically and which lie in a vertical plane, but not compressed.

Patagia small, slender, nearly flat, scarcely arched longitudinally, two or three times

longer than broad, tapering very gradually and rather regularly, but to a less degree near the apex, to a bluntly pointed tip, which is scarcely turned downward.

Fore wings (39-46) about two-thirds as long again as broad, the costal margin very slightly and regularly bowed, scarcely more so at the base, the outer angle abrupt but rounded off, the outer border curved a little at either end, nearly straight in the middle half, perhaps a little fuller in the δ , its general direction at an angle of about 65° with the costal margin, the inner margin straight, the outer angle well rounded off. Costal nervure terminating a little before the tip of the cell; subcostal with three superior branches, the first arising at about three-fifths the distance from the base to the apex of the cell; the second at about one-fourth way from there to the apex of the cell; the third at some distance before the apex of the cell and opposite the base of the second median nervure, forking beyond its middle; the cross veins closing the cell are bent at a considerable angle and are very faint excepting immediately next the main nervures. Cell half as long as the wing and about three and a half times longer than broad.

Hind wings with the costal margin gently convex at the base, beyond straight, the outer border pretty strongly rounded, rather fuller above than below and in the δ than in the ϕ , the inner border a little convex, the outer angle very broad. Submedian nervure terminating at the anal angle; internal nervure terminating a little beyond the middle of the inner border.

Androconia slightly fan-shaped, the lamina expanding a little from the base, the stem nearly half as long as the lamina.

Fore tibiae a little more than three-fifths the length of the hind tibiae; the fore legs either of the same structure as the others (ϕ); or the claws are subconnate, nearly straight and overlap at tip, and the paronychiae are wanting (δ); excepting in diminished size they differ little from the other legs, but the tibial spur is naked and no longer than an ordinary spine, the tarsal spines are less frequent and confined to two rows, the space between them sealed. Middle tibiae nearly five-sixths the length of the hind tibiae, provided at tip with rather short slender spines, mostly concealed by scales. First joint of tarsal a little longer than the three succeeding combined; the second as long as the third and fourth together or as the fifth alone; the fourth scarcely half so long as the second; joints furnished beneath with a triple row of slender spines, the apical spines of each joint longer; claws small, rather strong, considerably curved, tapering, finely pointed; paronychiae bifid, the superior lobe nearly as long as the claw, curved a little in the same direction as it, tapering a little; inferior lobe tapering considerably, rather long, curved strongly inward so as to be generally concealed from view; pulvillus wanting.

Upper organ of male abdominal appendages small but stout, gibbous, the lateral portions bearing each a posterior appressed lobe, provided at its posterior inner edge with an inward directed, delicate, slightly curving thorn, as long as the breadth of the lobe; claspers bulbous, or almost globular at base, emitting at tip a slender needle bent at base, so as to be directed inward and backward, crossing that of the opposite side.

Egg. Very depressed echinoid shaped, the whole upper surface hollowed and increasingly so toward the centre; covered with not very prominent tubercles, connected by fine raised lines; between every set of three, four or five of these a slighter prominence, connected by similar lines to the higher ones.

Caterpillar at birth. Head: ocelli four in number, arranged around a circular black spot, the posterior one largest, the other three about equal, two of them situated at equal distances along the upper border, the fourth below, nearly as far from the largest as the front upper one is. Body subcylindrical, tapering, flattened beneath and a little above, but still as high as broad, the sides well rounded though subrectiform, and the lower margin produced laterally a little. First thoracic segment bearing above in the middle a slightly raised, large shield, the sides of which converge strongly anteriorly, making the anterior border very short, while the posterior is long and well rounded. It bears three arcuate rows of warts, emitting long, forward and upward directed hairs, the anterior row consisting of three, the middle of five, and

the posterior of six warts; besides these, the segment is furnished with a row of warts emitting long hairs, parallel to and outside of the front border and sides of the shield; the last segment of the abdomen bears a similar row in a reverse position; besides these, behind the first thoracic segment, there is a laterodorsal series of high, conical warts, one to a segment in each row, situated a little in advance of the middle, and emitting very long, curved, backward sweeping, tapering hairs; also a ventrostigmatal row of small warts, three on each segment, not placed in a line, emitting straight, delicate, tapering, finely pointed hairs, of which one, a central one, is longer than the other two, and all are directed outward and a little downward, so as to reach the surface upon which the animal rests. In addition, there are on each side four longitudinal series of smooth lenticles, two of them larger and two smaller; the two larger have each one lenticle to a segment, placed in the middle, and consist of a supralateral and an infrastigmatal series; the smaller ones consist of a suprastigmatal series, two on a segment, at equal distance from either margin, and a laterostigmatal row, one on a segment, placed in the middle. Legs long and very slender, the basal joint short, conical, the remainder cylindrical and equal; claws pretty large, long, pretty strongly curved, tapering; prolegs short and rather stout, globular at base, beyond very short and half as broad, the hinder pair quite long, tapering but little.

Mature caterpillar. Head well rounded, rather broader than high, broadest above, tapering very slightly below, with a rounded curve which is rather broad and falls beneath, docked squarely at the labrum; it is apparently deepest in the middle, and has the front full. Triangle very large, much higher than broad, extending nearly to the summit of the head; a very few long hairs at the lower part of the head. Basal joint of antennae mammiform, pretty large, second about as long as broad, third not much smaller than the second, twice as long as broad, cylindrical, bearing at its apical edge a number of hairs, which conceal in part at least the fourth joint. Ocelli six in number, of uniform size, like a flattened hemisphere in shape, five placed in a strongly curving row, equidistant from each other, and separated by less than their own diameter, the lower two opposite the posterior base of the antennae, the others curving backward, the upper four on the arc of a pretty small circle, the sixth behind the others, a little further removed from the uppermost than from the fourth from the top, and forming with these rather less than a right angle. Labrum large, very broad, half as long as broad, the outer angles square but rounded off, the middle two-fifths of the front margin roundly and considerably excised. Mandibles armed at the tip with large, triangular, bluntly pointed teeth, half as long again as broad. Maxillae with the inner and outer palpi exactly similar in size and shape, the penultimate joint being about twice as long as broad, tapering, the apical minute, conical. The apical two joints of the labial palpi are similarly shaped but much smaller and proportionately slenderer. Spinneret long, and beyond the conical base equal and not very slender, the tip bluntly rounded, directed vertically.

Body pretty regularly arched longitudinally, with the posterior edges of the segments elevated a little, and thus showing the divisions plainly; the sides of the body slope abruptly, widening considerably at the base. Viewed from above elliptical, about equally rounded in front and behind, covered with minute dots, which a closer inspection shows to be made up of a raised centre from which radiate six nearly horizontal, very short rays, and from the centre a rather short hair; these are so thickly distributed as to give the appearance of a dense pile; provided also with a laterodorsal row of rather long hairs, four or five times longer, arising from simple papillae, and with similar long hairs at either extremity of the body and along the ventrostigmatal fold. Vesicle of seventh and lateral caruncles of eighth abdominal segments present (87: 14, 19); claws of legs long and very slender, heeled at the base, tapering, very gently curved; last joint of legs long and slender, equal; prolegs armed at the tip with a double, curving row of hooklets, about eighteen in number, very long and very slender, scarcely tapering, curving strongly and regularly, the tip bluntly pointed.

Chrysalis. Scarcely more than twice as long as broad; viewed from above, the sides are straight from the basal wing tubercle to the middle of the abdomen, but

diverging a little, so that the body is considerably broader at the latter place; the basal wing tubercle scarcely breaks the continuity of the line forward, where it is well arched, the front a little appressed; the posterior half of the abdomen has an elliptic curve, forming an arch whose height and breadth at base are equal. Viewed laterally, the thorax is highest in the middle of the posterior half of the mesothorax, scarcely falling posteriorly, in front curving at first a little more rapidly, and then directed about equally downward and forward, in nearly a straight line, to the front of the thorax. Abdomen highest, and very little higher than the thorax, at the third segment, on either side of it for an equal distance, in front to the extremity, very broadly arched; beyond this point, posteriorly, curving very rapidly downward, so as to be perpendicular at the junction of the eighth and ninth segments, and below this curved a little forward; transversely the middle of the thorax has the sides sloped toward each other at an angle of about 80° , scarcely or not at all hollowed in the middle, the sides below and the summit equally and rather broadly rounded; transversely the abdomen is regularly rounded, forming a perfect semicircle; the tongue exposed three-fifths way to tip of antennae, interposed between the inner edges of the legs; basal wing prominence consisting of a very slight, rounded elevation. Body covered with a delicate, raised, interrupted network of lines, continuous in a transverse direction, not elevated at the intersection; surface between traversed by exceedingly delicate, impressed lines of varying depth, and furnished here and there with a wart bearing a straight, erect, short, tapering hair. Hooklets of cremaster very short and exceedingly slender, the stem equal and nearly straight, the apical lobe bent suddenly over and strongly appressed to the stalk, transversely ovate, broadest apically.

This is a widely distributed genus, occurring in both hemispheres, from the southern limits of the Arctic regions to Lat. 30° N., and on the Asiatic continent even further south. The highest point it reaches in either hemisphere is about 63° N. Lat. In the western world it occurs throughout the United States (excepting in the Florida peninsula and perhaps the immediate borders of the Gulf of Mexico), and beyond almost to the treeless region of the north. It is still a matter of doubt whether we have more than one American species, with the probability that we have not; but, if not, it is an extremely variable form with a most remarkable history, which will be related under the species; nothing wholly comparable with it has been observed in the Old World.

The butterflies are of a lovely violet hue above, the female paler and having the costal border of both wings, and the outer margin of the fore pair, broadly covered with dark brown; in our species, a secondary form of the male has the whole upper surface dark brown; beneath, the butterflies are pale silvery gray or whitish, with a submarginal series of black-dots, followed inwardly by arrow-shaped spots, often confluent, so as to cloud the whole margin; besides, the fore wing has a transverse series of oblique, dusky dashes beyond the middle of the outer half, and the hind wings a tortuous extra-mesial series of dusky spots, of varying size, sometimes even forming a fuscous cloud; two dusky dots are found midway between this and the base of the wing.

The species are at once monogoneutic and digoneutic, according to the latitude, and probably to some degree the season. This has been well made out by Edwards for the American species, and is also claimed for the

European by Jenner Weir (Entom., xix: 50-52); and the two broods differ from each other wherever they occur, with slight exceptions. But whether single or double brooded, they hibernate in the chrysalis state, and the imago of the first generation (or, in the north, of the only generation) are among the very earliest butterflies to emerge from the chrysalis, and may be considered true harbingers of spring. The most delicate winged of all butterflies, and quite as active as most, they not only fly when nearly all insect life is still beneath the spell of winter, but seem no shorter lived on that account. Like violets and hepaticas in color, they fly in the season of these flowers. The eggs hatch in a week or less, and the chrysalis, if it does not pass over the winter, gives out the butterfly in about three weeks. If there is a second generation it differs from the first, or agrees with its latest member and flies in July, and is much less numerous than the preceding.

Speaking of our species, Gosse says (Lett. Alab., 144-145):—

It appears to be very pugnacious, attacking with Quixotic knight-errantry any intruder, no matter how much bigger than itself. It is particularly gamesome a few hours after sunrise; taking its stand on some prominent leaf of a bush, it rushes out upon every butterfly that passes by; then they perform such swift and tortuous evolutions that the eye is unable to follow them: this lasts only for a few seconds; for having pursued the traveller three or four yards, the [butterfly] returns to the very same leaf, to watch as before. . . . This constancy of resort to one individual leaf or twig is very singular and unaccountable: sometimes on my approach to one so situated, it has been alarmed and flown to a considerable distance, but, taking a flight round, it returns to the place; and presently there is the little thing alighting on the very leaf again.

The common European species, *C. argiolus*, is described by Meyer Dür as inhabiting the low and hilly parts of Switzerland, up to the height of 2700 feet, where, in sunny spots near the border of leafy forests, it hovers singly, at some distance from the ground, around the projecting branches of trees. It does not settle on the ground, nor, like other *Lycæniinae*, fly in meadows from flower to flower,—its whole conduct agreeing rather with that of the *Theclidi*. Our own species is constantly on the ground, alighting on damp spots, but like its European brother has no passion for flowers.

The transformations of the species are pretty well known. The caterpillars feed somewhat indiscriminately upon flowers, seed vessels and leaves of a great number and exceptional variety of plants, rarely the same even generically in Europe and America, though as a general thing the same families are selected: thus among the *Ranunculaceæ* we have *Cimicifuga*; among *Cruciferae*, *Nasturtium* (in confinement), and among *Anacardiaceæ*, *Rhus*—all these in America only. Among *Rhamnaceæ*, *Rhamnus* in both countries and *Ceanothus* in addition in America; among *Sapindaceæ*, *Aesculus* in America; among *Leguminosæ*, *Robinia* and *Dorycnium* in Europe and in America *Erythrina*, *Apios* and in con-

finement *Trifolium*; among *Rosaceae*, *Mespilus* and *Pirus* in Europe and *Spiraea* in America; and of other families of polypetalous plants, *Eschallonia* and *Hedera* in Europe and *Cornus* in America. Further we have among the *Gamopetalae*, *Viburnum*, one of the *Caprifoliaceae*, in America; among *Compositae*, *Cuscuta* in Europe and *Actinomeris* and *Verbesina* in America, besides *Dinorphanthes*, a cultivated form; among *Ericaceae*, *Erica* in Europe and *Vaccinium* in America; further, *Hex* in both countries; and in confinement, in America, *Begonia*, *Salix* and *Asclepias*. With such a list the caterpillars may surely be regarded as polyphagous.

The eggs are of a very depressed echinoid shape and covered with tubercles of diverse heights connected by delicate lines.

The body of the juvenile larvae, which is subcylindrical but tectiform, is covered with high conical papillae from which emerge long, curved hairs sweeping backward. The mature caterpillars are onisciform, about equally and somewhat rapidly sloped in front and behind and have a similar anterior and posterior curve. They have rather distinctly marked segments, are green in color with straight dorsal markings and oblique lateral stripes.

The chrysalids are well rounded, of a dark green or ferruginous color with dusky markings, rather short and stout, the abdomen considerably higher than the thorax.

EXCURSUS XXXIII.—DIGONEUTISM IN BUTTERFLIES: INTENSITY OF LIFE IN AMERICA.

And now you went beside the flowers, with eyes
Earnest as bees, restless as butterflies.

LEIGH HUNT.—*A Garden and Summer House.*

IN ALL plural brooded butterflies with an extensive distribution in latitude, the number of generations varies with the length of the season, and this will account for the apparent waste we often see as winter approaches, for such changes must be gradual, and in intermediate districts irregular, dependent upon the season. Where, as is sometimes the case, some chrysalids of each brood live until the following spring, it manifestly makes little difference how short the season may be, or how suddenly and actually any brood may be cut off; these chrysalids, and so the species, will survive. That this feature is more common than is generally supposed is shown by the increasing number of proofs brought forward of lethargic tendencies in caterpillars and of persistent torpor in many mid-summer chrysalids. It is also indicated by the variation in the numerical proportions of different broods; the winter is the severest season, and consequently the spring broods are ordinarily, and under simple conditions would always be, less numerous than the summer or autumn broods; generally the broods go on increasing in individuals as the season advances;

but in some it is not so, and it may be presumed that these are species which have not long enjoyed the privilege of a second brood, or, in other words, those in which a part of the chrysalids fail to persist until the following spring. In the case of our tiger swallow-tail, which is found from Alaska to Florida, we have a butterfly which is single brooded in the north and double brooded in New England; but the second brood is much less abundant than the first, and the change as we go north is probably effected by the lingering development of some caterpillars and the disposition of chrysalids to winter early. Wherever in a double brooded butterfly the second brood is less abundant than the first, it is probable that the butterfly is partly single and partly double brooded—that is, that the early brood of a given year is made up of the direct descendants of each brood of the preceding year.

Occasionally, the difference in the number of broods affects the mode of hibernation. The black swallow-tail, for instance, is triple brooded in the south, and hibernates as a butterfly and perhaps also as a chrysalis; in the north it is double brooded, and hibernates only as a chrysalis.

Digoneutism or polygoneutism, then, is either a device of nature for the better perpetuation of the species, by varying the conditions of its existence at any given time, and so multiplying the chances of successfully meeting opposing or unfavorable agencies; or it is simply taken advantage of by nature as a means thus to vary the conditions. The particular problem difficult of solution which it carries in its train is this: In some species—and it would appear to be no very uncommon occurrence, and to be found among moths as well as butterflies—the result of summer dormancy in the caterpillar or prolonged life in the chrysalis is that, by some unexplained common impulse, the caterpillars or the chrysalids that arouse after lethargy, and do not hibernate, more frequently than otherwise do this at such a time that the resulting butterfly flies with its nephews and nieces instead of with its brethren and sisters, i. e., it bridges over with considerable accuracy the interval between two generations in mid-summer, just as happens from easily perceived causes when winter intervenes. Who solves this problem will win deserved renown.

What may be the exact climatic features which determine the number of generations of a butterfly has not yet been studied; but there are some curious difficulties in the way of understanding them. *Vanessa cardui*, for instance, is double brooded in New England, both in the districts where the contrasts of heat and cold, moisture and drought, are excessive—that is, where the climate has those peculiarities which are termed “continental”; and also on islands such as Nantucket in southern New England, where a much greater evenness prevails and the climate partakes of an “insular” character; yet in the valleys of Switzerland, where perhaps of all places in Europe the climate presents the greatest and most sudden inequalities,

and therefore is most similar to that of New England, and certainly more "continental" than that of Nantucket, this butterfly is single brooded. We have exceedingly few identical butterflies in Europe and the United States, and this apparently is the only one of them that differs in its broods in the two countries; but there are several of our butterflies which are represented by very closely allied species in Europe, and in half a dozen or more of these we find quite similar disparities, all of which are in the same direction.

The European tortoise-shell (*Aglais urticae*), for example, is generally double brooded; occasionally a triple brood is mentioned; it is one of the commonest of European butterflies, and reaches from the North Cape to the Mediterranean; our congeneric species, the American tortoise-shell, is rarely found south of the northernmost parts of the United States, and yet it is triple brooded in all parts of Canada. Even *Brenthis montinus* of the White Mountains is probably double brooded, while all the mountain species of Europe are single brooded. *Everes amyntas*, again, occurs throughout Europe, with the exception of certain northern and northwestern portions, and is double brooded; our tailed blue, named for the resemblance to its European congener, and by some careless authors considered identical with it, is also a wide-spread insect; but even in New England, which is at the northern limit of its eastern range, it is triple brooded. The wide-spread European blues, *Rusticus argus* and *R. negon*, the silver-studded blue, are usually placed among monogoneutic insects, and the latter certainly has only a single brood in England (where it is the only one of the two found); Meyer Dür is in fact almost the only author who claims these species as digoneutic; both of them occur in southern Europe; our pearl-studded violet (*Rusticus scudderii*), closely allied to these and an insect hardly known south of the Canadian border, is double brooded. Our chequered white (*Pontia protodice*) is triple brooded, and the European Bath white (*P. daplidice*) only double brooded, while our common clouded and orange sulphurs (*Eurymus philodice* and *E. eurytheme*) are triple brooded in the north, perhaps polygoneutic farther south, and the closely allied European species only single or double brooded.

But the most striking example of all will be found in the species of the genus *Iphiclides*. The European *I. podalirius* is confined to the Mediterranean region, while our zebra swallow-tail belongs to the southern half of the United States; the regions are therefore fairly comparable; yet we find no mention of more than two broods of *I. podalirius*, while Mr. Edwards has shown that, even as far north as the Appalachian valleys of West Virginia, *I. ajax* has four and sometimes five generations during the year.

These cases might perhaps be multiplied, and it should be added that

there is no reversal of the rule: among all the butterflies properly comparable on the two continents, *there is no single instance where the European butterfly has more broods than the American.*

This result of a comparison of the annual histories of similar European and American butterflies thus furnishes but another instance of that intensity which seems to characterize all life in America. The expenditure of nervous and vital energy, against which physicians vainly inveigh, which superannuates our merchants, lawyers, clergymen, and other professional men, is not induced by the simple passion for gain, place, power or knowledge, but by an uncontrollable restlessness, a constant dissatisfaction with present attainments, which marks us as a hurrying, energetic, enterprising people. My own experience in the preparation of the present work has been that studies of precisely the same nature and undertaken under similar external conditions are accompanied by a very different mental state on the two continents. In Europe we are content to plod industriously on, unconscious of the need of relaxation; in America we bend with nervous intensity to our work, and carry the same excitement into the relaxation which such a life inevitably demands. After a long absence in Europe, a keen observer may even be directly conscious of this quickened life.

Now to what shall we ascribe such peculiarities in animal life? Naturally we look to climatic influences, and our attention is first attracted by the well known fact that if we compare two places in Europe and America having the same mean annual temperature, the extremes of variation will prove much greater on this side of the Atlantic. For example, while the mean annual temperature of New York is about the same as that of Frankfort, the summer temperature of the former is that of Rome and its winter that of St. Petersburg. Moreover, the changes from summer to winter and from winter to summer are more immediate in America; or, in other words, the summers and winters are longer by about three weeks. Such long and hot summers are of course favorable to the multiplication of broods in butterflies whose history allows a repetition of the same cycle more than once a year; the length of the winter is of slight consequence, as long as the insects can survive it; and it can have no influence upon the number of broods, unless there be species (of which we know nothing) able to resist a cold winter only in certain stages of existence, and a multiplication of whose broods might require some pliability in this respect. Not only, too, are our summers longer and hotter, but they enjoy a marked preponderance of sunshine, as compared with European summers; and this alone would almost seem capable of producing the variation we have noticed in the number of broods.

In an extremely interesting article (*Actes Soc. helv. sc.*, 1853, 138-150) on the effect of our climate on manners and customs, written by the

Swiss naturalist Desor, who resided several years in the United States, this writer attributes everything to the far greater dryness of the climate, when comparing eastern America and Europe. This produces, according to him, a nervous irritability, the recognition of which has compelled a measure of self-restraint, and the exercise of this has gone far to make the development of our political institutions possible! What a future is before the future inhabitants of our arid plains!

Differences will be found in all other climatic phenomena of the two continents. "From Europe as a standard," says Blodgett,* "the American climate is singularly extreme both in temperature, humidity, quantity of rain, wind, and cloudiness or sensible humidity. The oscillations of the conditions are greater, and they vibrate through long measures above and below the average. All the irregular as well as regular changes are of this sort, and the European observer defines the climate as directly antagonistic to that he has left." These differences, however, as Humboldt and others long ago pointed out, have a broader bearing than the above statements would imply; for they are characteristic of the eastern shores of both worlds as opposed to the western meteorological phenomena of the eastern United States being almost precisely paralleled by those of northern China, where great excesses of temperature occur, with wide variability, long summers and winters, and rapid transitions.

Perhaps on these grounds we can most simply account for the difference in the number of broods in certain butterflies on the two continents; but, if so, then it follows that we ought to anticipate similar differences between the broods of some of the species found both in Europe and in eastern Asia; a point about which we can assert absolutely nothing, for want of data. These grounds, however, will certainly be insufficient to account for the differences to which we have alluded in man; for what contrast could well be greater than that existing between the national character of the Chinese and that of the Americans! We are rather forced to believe that the causes of the distinction between the European and the American, if these are due to physical agencies, must chiefly be sought elsewhere.

CYANIRIS PSEUDARGIOLUS.—The spring azure.

[The spring azure (Scudder); pale blue butterfly (Maynard).—The different forms have received specific names: *C. p. lucia*: Blue Lucia butterfly (Harris); spring azure (Scudder), *C. p. violacea*: Dotted azure (Scudder), *C. p. neglecta*: Pale azure (Gosse); azure blue butterfly (Harris); southern azure, pale azure (Scudder).]

Argus pseudargiolus Bois.-LeC., Lép. amér. sept., 118-119, pl. 36, figs. 1-5 (1833);—Morr., Syn. Lep. N. Am., 82-83 (1862).

Lycaena pseudargiolus Doubl., List. Lep.

Brit. mus., ii: 45 (1847);—Edw., Proc. ent. soc. Philad., vi: 204-206 (1886); Butt. N. Amer., i, Lyc. ii, figs. 1-3 (1870); ii, pl. Lyc. ii, iii, pp. 1-16 (1884); Can. ent., v: 223-224 (1873); vii:

* Climatology of the United States, p. 221.

81-82 (1875); x: 1-14, fig. 80 (1878); Pap., iii: 85-97 (1883);—French, Rep. Ins. Ill., vii: 158 (1878); Butt. east. U. S., 286-291, figs. 78-80 (1886);—Middl., Rep. Ins. Ill., x: 95 (1881);—Fern. Butt. Me., 96-92, figs. 29-31 (1884);—Mayn., Butt. N. E., 39-40, pl. 6, figs. 49, 49a-b, 49a-c, 49d (1886).

Cupido pseudargiolus Kirb., Syn. cat. Lep., 371 (1871).

Plebeius pseudargiolus Kirb., Syn. cat. Lep., 653 (1871).

Cyaniris pseudargiolus Scudd., Syst. rev. Am. butt., 34 (1872);—Butt., 174-179, 308, figs. 34, 35, 148-152 (1881).

Cyaniris iadon Butl., Ent. amer., 1: 53 (1885).

CYANIRIS PSEUDARGIOLUS LUCIA.

The early spring northern form.

Polyommatus lucia Kirb., Faun. bor. am., iv: 290-300, pl. 3, figs. 8-9 (1837);—Morr., Syn. Lep. N. Am., 90-91 (1862);—Harr., Ins. inj. veg., 3d ed., 275, fig. 106 (1862).

Lycaena lucia Doubl., List. Lep. Brit. mus., ii: 45 (1847);—Streek., Lep., 82-83 (1874).

Cyaniris lucia Scudd., Syst. rev. Am. butt., 34 (1872); Can. ent., vii: 61-66 (1876).

Lycaena pseudargiolus form *lucia* Edw., Butt. N. Amer., ii, pl. Lye. ii, fig. 1, 1, 2, 2 (1884).

Lycaena pseudargiolus form *marginata* Edw., Butt. N. Amer., pl. Lye. ii, figs. 3, 4, 4 (1884).

CYANIRIS PSEUDARGIOLUS VIOLACEA.

The typical spring form.

Lycaena violacea Edw., Proc. ent. soc. Philad., vi: 201-204 (1860); Trans. Am. ent. soc., 1: 287 (1867); Butt. N. Am., i, Lye. i, figs. 1-4 (1869).

Cyaniris violacea Scudd., Can. ent., vii: 61-63 (1876).

Cyaniris pseudargiolus var. *violacea* Scudd., Bull. Buff. soc. nat. sc., iii: 114 (1876).

Argus pseudargiolus Boisd.-Lac., Lep. Am. sept., pl. 36 fig. 3 (1833).

Lycaena pseudargiolus form *violacea* Edw., Butt. N. Amer., ii, pl. Lye. ii, figs. 5, 5, 6 (1884).

CYANIRIS PSEUDARGIOLUS VIOLACEA NIGRA.

The dark male of the spring form.

Lycaena pseudargiolus form *nigra* Edw., Butt. N. Amer., ii, pl. Lye. ii, fig. 7 (1884).

CYANIRIS PSEUDARGIOLUS NEGLECTA.

The summer form.

Lycaena neglecta Edw., Proc. acad. nat. sc. Philad., 1862, 56 (1862); Butt. N. Am., i, Lye. ii, figs. 4-6 (1870);—Saund., Can. ent., 1: 100 (1869);—Lintn., Can. ent., vii: 122-123 (1875); Ent. contr., iv: 55-56 (1878);—Middl., Rep. Ins. Ill., x: 96 (1881).

Cyaniris neglecta Scudd., Syst. rev. Am. butt., 34 (1872); Can. ent., vii: 61-66 (1876).

Lycaena pseudargiolus form *neglecta* Edw., Butt. N. Amer., ii, pl. Lye. ii, figs. 10, 10, 11, 12, 13, 14, 15, 15 (1884).

Papilio argiolus Smith-Abb., Lep. Ins. Geo., 29-30, pl. 15 (1878);—Abb., Draw. Ins. Geo. Brit. mus., xvi: 57, 212 (ca. 1900).

Polyommatus argiolus Harr., Hitchc. Rep., 590 (1833).

Polyommatus pseudargiolus Gosse, Lett. Alab., 144-145 (1857);—Harr., Ins. inj. veg., 3d ed., 274, fig. 105 (1862).

Lycaena pseudargiolus Edw., Butt. N. Am., i, pl. Lye. ii, figs. 4-6, 2 pp. (1870).

Lycaena pseudargiolus form *pseudargiolus* Edw., Butt. N. Amer., ii, pl. Lye. ii, figs. 8, 9, 9, 18, 19 (1884).

Polyommatus dentargiolus Harr., MS., Ent. corr., 160 (1869).

Figured by Glover, Ill. N. A. Lep., pl. 28, figs. 2-4; pl. A, fig. 14; pl. E, figs. 4, 5; pl. F, figs. 5, 6; pl. G, fig. 10, ined.

(Not *Papilio argiolus* Linn., but possibly *Pap. iadon* Cram).

Naître avec le printemps, mourir avec les roses;
Sur l'aile du zéphyr nager dans un ciel pur;
Balancé sur le sein des fleurs à peine écloses,
S'enivrer de parfums, de lumière et d'azur;
Secouant, jeune encore, la poudre de ses ailes,
S'envoler comme un souffle aux voûtes éternelles,
Voilà du papillon le destin enchaîné.
Il ressemble au désir, qui jamais ne se pose,
Et sans se satisfaire, effleurant toute chose,
Retourne enfin au ciel chercher la volupté!

LAMARTINE.—*Le Papillon*.

... thou art much too fair
To be death's conquest and make worms thine heir.
SHAKESPEARE.—*Sonnet*.

Imago (6: 1, 3-5, 8, 12; 13: 4, 7). Head covered with black scales and hairs, with a longitudinal line of whitish hairs running down the middle of the front and summit, furnished behind with a mass of forward reaching dark brown scales with a few intermingled white ones upon them; sides, especially below, almost entirely white; eye

bordered equally by a pretty broad rim of pure white scales, interrupted at the base of the antennae and sometimes for a considerable space behind them and connected at the lower portion of the front by a similar white band; basal joint of antennae tipped behind with white. Palpi almost entirely silvery white, at least the upper portion of the middle and apical joints black, the fringe below white, mingled with black rather profusely in the apical half. Antennae black, the joints of the stem annulated rather narrowly with white at their extreme base, excepting on some of the basal joints beneath; club black, the apical two joints dull orange, two or three joints before them white above.

Thorax covered above with minute, recumbent, black scales and long, violaceous hairs, becoming pale, gray and brown on the prothorax; beneath covered with white hairs and scales. Legs white, the tibiae much marked with blackish brown, especially at the base, and the middle of each half above and to a less degree and more irregularly on the sides, the tibiae heavily marked above with black, especially beyond the basal joint, all their tips white. Spurs dark tipped; spines black. Claws yellowish brown, edged with blackish.

Wings above (in the form *neglecta*) nearly uniform slightly pale bluish violet with no approach to purplish, the central parts of the wings occasionally very slightly paler, the hind wings usually to a considerable extent being whitish blue excepting near the base and the outer border and in the vicinity of the nervules; the costal nervure, subcostal nervules and occasionally most of the other nervules in the fore wing are faintly tinged with hoary violet, the subcostal nervules tipped minutely with black, between which the costal edge is hoary blue, but on the basal half fuscous; the outer border is edged with black in the hind wings as a mere thread. In the fore wings narrowly but slightly infringing on the costal margin above, attenuating to a mere thread below; hind wings with a submarginal row of small, indistinct, sometimes obsolete, deeper blue spots (δ); or of the same or a slightly fainter violet upon the fore wings as far upward as the middle of the cell, and excepting a broad marginal belt, half as broad again as an interspace, which, with the costal margin and a slender transverse streak marking the tip of the cell, is blackish brown; the middle and sometimes the whole of the outer portion of the violaceous space becomes rather suddenly pale, usually with scarcely a violaceous tinge; hind wings violaceous only along the basal half of the median and submedian nervures and occasionally to a slight extent on the subcostal nervure, most of the rest of the wing being pale, almost white, occasionally faintly and slightly flecked with grayish, most of the costal border as far as the subcostal nervure grayish and the whole extent of the nervures including the tip of the cell marked to a greater or less extent with grayish fuscous, sometimes having an olivaceous tinge; outer border edged with a thread of blackish followed by a slender pale line, and this by a submarginal row of blackish fuscous spots in the interspaces (φ); inner margin of hind wings, as far as the submedian, pale; fringe of fore wings pale, broadly and abruptly interrupted with blackish fuscous or grayish fuscous at the nervure tips in the lower half, above mostly blackish fuscous, minutely tipped with pale and sometimes narrowly interrupted with pale in the interspaces; fringe of hind wings pale or whitish, the basal half occasionally and very inconspicuously flecked with fuscous and also occasionally very narrowly interrupted with fuscous at the nervure tips.

Above (in the form *violacea*) uniform bluish violet, inclining to purplish, the hind wings seldom any paler than the fore wings, the costal edge of the fore wings fuscous on the basal half, beyond hoary blue interrupted at the nervure tips with blackish; the outer border is edged with black in the hind wings as a mere thread, in the fore wings narrowly, but slightly infringing on the costal margin, above, attenuated to a mere thread below (normal δ); or uniform quite dark slate brown, some of the nervures occasionally flecked distantly with blue, the outer border of the hind wings edged with a thread of black, followed sometimes by a few inconspicuous blue scales; inner margin of hind wings more or less flecked with white or gray (δ , form *nigra*); or of the same, perhaps a little darker, violet of the normal male on the lower lower

portion of the wings, on the fore wings as far upward as the middle of the cell and outward to within the distance of the width of an interspace from the outer border, beyond which it is dark or blackish brown; the tip of the cell faintly marked by a transverse, dusky streak; on the hind wings, excepting a broad, dark band on the costal margin, a marginal thread of black on the outer border, and a submarginal series of small, blackish spots in the interspaces; the violet is not uniform in tint, becoming very gradually and very slightly paler on the outer portion of the fore wings and bathed in a much paler or whitish tinge over all but the basal half of the median area or over at least the space between the middle subcostal and the median nervules; the inner margin of the hind wings whitish (♀); fringe of fore wings more or less fuscous at the extreme base, beyond whitish, abruptly and generally not very broadly interrupted with blackish fuscous at the nervure tips, often and especially in the upper half of the wing almost entirely blackish fuscous; fringe of hind wings whitish, sometimes entirely so, but more often obscured to a greater or less extent, especially below, by fuscous and frequently interrupted abruptly and rather narrowly with blackish fuscous.

Above (in the form *lucia*) nearly uniform bluish violet, scarcely in the least inclining to purplish, the central parts of the wings occasionally a very little paler, but the hind wings seldom paler than the fore wings, the costal and branches of the subcostal faintly marked with hoary violet, tipped faintly with fuscous, between which the costal edge is hoary blue, the remainder being fuscous; the outer border is edged as a mere thread with blackish, infrequently expanding very slightly on the upper portion of the fore wings, but never to the extent that occurs in the other species (♂); or a little darker violet, inclining slightly more to purplish upon the whole of the hind wings and on the lower basal portion of the fore wings, excepting the extreme base, as far upward as the middle of the cell, and outward to within a distance from the outer border equal to the width of an interspace on the lower portion of the wing, and to a little greater distance above, in all of which it is dark fuscous; in the basal half of the cell, the violet often extends to its upper limit and the tip of the cell is marked by a dusky, transverse streak; the tint of the hind wings is as deep and equal as that of the fore wings; the outer border of the hind wings is edged with a blackish thread, sometimes expanding minutely at the nervure tips, and is followed by a submarginal row of small blackish spots (♀); the inner border of the hind wings is somewhat paler; fringe of fore wings mostly blackish fuscous, interrupted abruptly and either very narrowly or pretty broadly with pale or whitish at the interspaces, below the median nervule often pale on the basal and fuscous on the apical half; fringe of hind wings usually whitish, interrupted abruptly and narrowly, more broadly below than above, with brownish fuscous; sometimes almost wholly fuscous, though generally whitish above the middle subcostal nervule.

Beneath (in the form *neglecta*) uniform very pale ash gray, scarcely tinged with pale bluish. *Fore wings* with the apex of the cell marked by a slender, transverse, obscure, pale fuscous streak edged faintly with pale; middle of the outer two-fifths of the wing with a transverse, usually mostly obliterated series of pale, occasionally dark, fuscous, very slender, short bars, arranged, so far as present, as in the other forms; outer margin usually edged very faintly with a thread of pale fuscous, within which is sometimes a submarginal series of faint, pale fuscous, small, round spots and more frequently a series of slightly darker but still pale fuscous lunules, distant by more than an interspace from the outer border, wanting or less distinct on the upper half of the wing. Fringe white, narrowly and abruptly interrupted at the nervure tips, on the apical half with dull fuscous. *Hind wings* with a basal series of three small, roundish, blackish spots, sometimes scarcely edged with pale, in the costo-subcostal interspace, the middle of the lower half of the cell and the internal interspace, the lowest frequently and the middle one occasionally absent; the lowermost is situated at the middle of the basal half of the inner border and the three form rather more than a right angle; the tip of the cell is marked obscurely as in the

fore wings and beyond it is an extra-mesal irregular series of small blackish or dark fuscous spots or dots, arranged quite as in violacea; those in the lower subcostal and upper median interspaces are frequently absent and often many of the others, the uppermost being the most persistent; they are generally reduced to faint dots or slender streaks, but when present they undergo the same variety of form that holds in violacea; the outer margin of the wing is faintly edged with a thread of pale fuscous, followed by a submarginal series of small round spots, largest and darkest, generally blackish, on the lower half of the wing, smaller, paler, sometimes obsolete, but generally pale fuscous on the upper half; this is followed by a series of pale fuscous, strongly bent linear lunules darker nearer the inner border, often obsolete toward the costal border, distant at the farthest from the outer border by from one and a half to two interspaces. Fringe silvery white, occasionally, especially on the lower half of the wing, flecked slightly with pale fuscous.

Beneath (in the form *violacea*) uniform pale ash gray, occasionally begrimed slightly with fuscous but generally with a faint, pale bluish tinge. *Fore wings* with the apex of the cell marked by a rather slender, equal, scarcely bent, transverse, fuscous streak; middle of the outer two-fifths of the wing with a transverse, considerably curving series of six fuscous or blackish fuscous, short, moderately broad bars, sometimes very faintly and narrowly edged with pale; that in the lower subcostal interspace and those in the interspaces below it are arranged in a slightly curving or nearly straight row, subparallel to the outer border, while the uppermost, in the next to the lowest subcostal interspace, is removed inwards from the line by about its own length; those in the lowest subcostal and the medio-submedian interspaces are transverse, the latter usually broken; the others more or less diagonal, directed from above downward and outward; the outer border is edged with a thread of blackish fuscous, sometimes expanding very slightly at the tips of the nervules, followed by a submarginal series of quite small, obscure fuscous spots in the interspaces, followed at an equal distance by an obscure fuscous or dark fuscous, usually bent bar, opening outwards and often obsolete or nearly so in the upper half of the wing; in the medio-submedian interspace it is never bent. Fringe at base bluish-ashy mingled with fuscous, at tip white, interrupted abruptly and not very broadly with dark fuscous, often extending to the base and sometimes occupying the whole apical half. *Hind wings* with a basal series of three rather small, round, blackish spots, faintly edged with pale, in the costo-subcostal interspace, the middle of the lower half of the cell and the internal interspace, the latter situated next the middle of the basal half of the inner border; the upper two spots are on a line with the lowermost spot of the extra-mesal series to be mentioned, and the lower two on a line with the uppermost spot of the same series; the tip of the cell is marked by a transverse, rather slender, equal, fuscous streak, formed of two scarcely curving halves, each opening outward; beyond this is a transverse series of eight blackish, blackish fuscous or fuscous spots, very faintly rimmed with whitish; all but that in the medio-submedian interspace, which is transversely curved or bent, opening inwards, are usually roundish or oval, but occasionally linear, especially in the subcosto-median interspace, where it is either longitudinal or slightly diagonal; the uppermost is slightly larger than the others and sometimes extends linearly outward a little; the upper two, in the costo-subcostal and upper subcostal interspaces are parallel to the upper two spots of the basal series and removed outward from the tip of the cell by their own width; the four succeeding ones form a gently curving row opening upwards and a little inwards, that in the lower subcostal interspace varying from one-fourth to one-half the distance from the tip of the cell to the outer border, that in the lower median interspace just below the streak at tip of cell; the spot of the submedio-internal interspace is nearly in continuation of this curve and at the middle of the outer border, that in the medio-submedian being removed further outward and about one-half the width of an interspace; the outer margin of the wing is edged with a delicate fuscous line, followed by a submarginal series of small, round, dark fuscous spots, followed again, at an equal distance, by slender, obscure, pale fuscous, strongly bent or curving

lunules or lines, outside of which the whole wing is often bathed to a very slight or sometimes even a considerable extent with brownish fuscous. Fringe silvery white, often marked to a slight degree with fuscous on the basal half and interrupted abruptly, usually very narrowly, sometimes rather broadly, with brownish fuscous at the nervure tips.

Beneath (in the form *lucia*) uniform pale ash gray, with a faint, pale bluish tinge. *Fore wings* with the apex of the cell marked by a moderately broad, equal, transverse, dark fuscous streak; middle of the outer two-fifths of the wing with a transverse, considerably curving series of six dark or blackish fuscous, short, moderately broad bars, sometimes very faintly and narrowly edged with pale; all but the upper one are arranged in a curving or nearly straight row, subparallel to the outer border, while the uppermost, in the next to the lowest subcostal interspace, is removed inwards from the line usually by a little more than its own length; all of the bars are sometimes transverse, but those in the subcosto-median and upper, and sometimes the lower median interspaces, are frequently diagonal, directed from above downward and outward; outer border edged with a thread of blackish fuscous, often obscured above, followed by an obscure, submarginal series of small, dark fuscous spots in the interspaces, followed at an equal distance by an obscure, dark fuscous series of continuous, strongly curved, transverse bars, between which and the outer border the nervules are frequently infuscated, and the whole margin of the wing is usually washed in a dull, obscure, fuscous tinge. Fringe generally pale along the extreme base, beyond grayish fuscous or whitish, interrupted rather narrowly and abruptly with blackish or blackish fuscous at the nervure tips. *Hind wings* with a basal series of three not very large, round spots, faintly edged with pale, one black one in the subcostal interspace, one black or dark fuscous one in the middle of the lower half of the cell, and a third black one in the internal interspace, the latter situated at the middle of the basal half of the inner border, arranged in relation to the extra-mesial band, as in violacea; the tip of the cell is marked by a transverse, moderately slender, equal, fuscous streak; beyond this is an extra-mesial, transverse series of blackish or blackish fuscous, quadrate spots, narrowly and indistinctly edged with pale, arranged quite as in violacea, but with those in the two parts of the series almost or quite continuous, when the markings are otherwise distinct; but usually all the markings in the middle of the wing are blurred and run together to a considerable extent, so as in extreme, but not uncommon examples to present a grayish fuscous, large, irregular, central, subtriangular patch, bounded externally by the outer limits of the extra-mesial spots, above by a line connecting the middle of the lower border of the cell and the lower subcostal nervule, with projections extending toward the two costo-subcostal spots, and below by a line connecting the middle of the lower border of the cell and the submedian nervure where the extra-mesial band crosses it; the outer border of the wing is broadly bathed, usually to a considerable extent, though sometimes but little, with dark grayish fuscous, bounded interiorly by a zigzag line, formed by a series of strongly bent, narrow bars in each interspace, darker than the rest of the outer border in specimens where the outer border is not pretty gray, and reaching, in the middle of the interspaces, to the distance of one and one-half interspace widths from the outer border; within this, even in the darkest specimens, may be seen a submarginal row of rather small, blackish, round spots, and a blackish thread edging the border. Fringe white, in the lower two-thirds of the wing often more or less gray, by an admixture of fuscous, and throughout interrupted abruptly and rather broadly at the nervure tips with dark fuscous.

Abdomen above black or blackish brown, sides profusely covered with blue scales, particularly below, under surface white, often with a yellowish or bluish tinge. Male abdominal appendages (34:33, 34): upper organ furnished outside posteriorly with a bulbous, subtriangular lobe, bearing at its inner extremity a short, pointed, inward directed thorn; clasp with the bulbous base rather large, the thorn a little curved and fully one-fourth as long again as the base.

CYANIRIS PSEUDARGIOLUS NEGLECTA.*

Measurements in millimetres. Length of tongue, 3.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	12.25-15.5	15-16.5	16-17.	13-15.	16-16.5	16-17.15
antennae.....	6-7.4	6.75-7.5	7.25-7.5	5.5-6.5	7.	7.35
hind tibiae and tarsi....	2.75-4.25	3.75-4.4	3.5-4.5	3.25-3.9	3.6-4	3.6-4.2
fore tibiae and tarsi....	2-2.25	2.25-2.4	2.6-2.6	2.5-2.6	2.5-2.8	2.5-2.8

CYANIRIS PSEUDARGIOLUS VIOLOCEA.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	12.75	14.	15.	13.5	14.	16.
antennae.....	6.	6.5	6.6	6.	6.	7.
hind tibiae and tarsi....	3.5	3.75	3.75	3.5	3.5	4.
fore tibiae and tarsi....	2.	2.4	2.5	2.2	2.5	2.6

CYANIRIS PSEUDARGIOLUS LUTEA.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	12.	14.	14.5	13.	13.5	14.
antennae.....	5.75	6.5	6.75	6.	6.	6.25
hind tibiae and tarsi....	3.25	3.5	3.6	3.4	3.5	3.6
fore tibiae and tarsi....	2.1	2.25	2.3	2.5	2.6	2.5

Dimorphic forms. The distinctions between these have been pointed out above in describing the markings of the wings. No reference has been made to the form *platus*, as it is wholly Pacific, but its range will be mentioned further on, and the polymorphism of the species discussed.

Aberrations. *C. p. FUMIDA.* The intensest amount of markings on the under surface of the hind wings of this species is reached in individuals (the so-called form *marginata*) where the outer border is margined with a broad, fuliginous border having a distinctly crenulate interior edge and enclosing a series of submarginal dots, and in which the whole disc of the wing is covered with an extensive, fuliginous patch, including all the spots, excepting those on the inner border, which thus become, to a greater or less extent, suffused together. In a single ♂ in the collection of Mr. Roland Thaxter, the extent of these fuliginous markings is so great that the spots on the inner margin also are included, and the whole wing is fuliginous (paler along the nervules) excepting a small basal patch crossing the entire wing, and a transverse, interrupted, rather narrow, arcuate, silvery gray band, narrowing from above downward, margined on either side with blackish fuscous, running subparallel to the outer border of the wing, and at fully two interspace's distance from it. That this is truly a suffused variety is plain from the extreme narrowness, comparatively speaking, of the silvery gray band, and from the fact that on the fore wing not only is the fuliginous outer border of rather more than excessive breadth, but the extra-mesial spots are broadened, more or less blended, rather fuliginous than blackish, and those of the median interspaces accompanied by elongate, broad blotches of faint fuliginous, filling almost the entire remainder of the interspaces, toward the base of the wing. The fringe is less distinctly alternate than usual, the darker color being much in excess. The expanse of this specimen is 30 mm.

C. p. PSEUDORA. In the collection of the Boston Society of Natural History is a ♀ specimen of this species collected at Milford, N. H., on May 23d, by Mr. Sanborn, which differs from the normal ♀ in a peculiar manner. The upper surface varies only as we may expect occasionally to happen, the basal two-thirds of the costal border being heavily specked with violet, and the outer portion of the hind scarcely show-

*The figures after the dashes are from individuals of typical *pseudargiolus*.

ling any trace of submarginal spots; the latter feature is the more remarkable since the same part of the under surface is quite heavily marked; on the under surface the extra-mesial series of spots, in both the fore and hind wings, is removed outwards and has become confluent with the submarginal series of bent bars, making the markings of the outer border unusually heavy, while the spear-shaped markings of the submarginal row are retained, intensified, particularly on the hind wings; in the fore wings the spot of the next to the lower subcostal interspace is retained independent of the outer markings, although removed far toward the border; at the base of the hind wings, the lower spot is absent, while the spots of the costo-subcostal interspace and of the cell are enlarged and deepened in tint, and are perhaps a very little nearer the base than usual; the apex of the cell is only marked by a slender, pale fuscous streak, so that the centre of the hind wings, instead of being heavily blotched and infuscated, is almost entirely of the pale ash gray of the basal color of the wing, while the marginal markings are broadened, and on their inner margin deepened in tint, presenting an appearance in marked contrast to the normal type of *lucila*. The upper surface, however, leaves no doubt to which of the forms of the species we should refer this aberrant individual. A very similar specimen, but with the disc of the hind wings beneath heavily infuscated, is figured by Edwards (Butt. N. Amer., ii, Lye. ii, fig. 25).

A rather curious ♀ specimen, showing an exceedingly early stage of suffusion in the same direction as the last, was taken by Mr. F. H. Sprague, in Wollaston, Mass., on May 10. The only way in which it differs from the ordinary females in which the sub-mesial transverse band is distinct, is in the running together of the costo-subcostal spots of this series (which are here nearer the base than usual, being in direct and straight continuation of the dusky streak closing the cell) with the same spots of the basal series, forming in the costo-subcostal interspace a striking, dumb-bell shaped bar, whose outer extremity is connected beneath with a continuous, slenderer, curved streak, formed of the discal streak and the lower spots of the submesial series; and together forming a capital cursive T (T) upon one side and its reverse on the other.

Hermaphrodites. Edwards has figured (Butt. N. Amer., ii, pl. Lye. ii, fig. 23) a specimen taken at Coalburgh, W. Va., in which the left wings with the body have male characteristics, while the wings of the right side are colored as in the female. Mr. Edwards says "it was a male, as appeared on exposing the genital organs." The specimen is now in the collection of Dr. W. J. Holland, and as no such enquiry had ever before been made, I asked him to examine the scales of the male side, to see whether androconia would be found. He removed about one hundred and fifty scales from this side, and sent me sketches of the different forms and their relative abundance; among them was just one of the androconia; so that in this strange hermaphrodite the male side preserves even such microscopic features as the androconia. He also examined the opposite wing, without finding any androconia.

Accessory sexual peculiarities. Besides the difference in the coloring of the wings, described on the preceding pages, the male is peculiar for the androconia which are scattered, apparently without definite position, over the upper surface of the wings. These (46: 30) have slightly divergent sides, so that the regularly convex apex is nearly half as broad again as the sloping base; they are slightly longer than broad and furnished with about ten parallel rows of exceptionally large, bead-like spots, which are confluent in the basal half of each row; the stem tapers throughout, is almost half as long as the lamina and gradually expands to it. The extreme breadth of the lamina is about .0075 mm., these being much smaller than the ordinary scales.

Egg 65: 14, 15, 18. Surface covered uniformly, both above and on the sides, with raised rounded points averaging .042 mm. in distance apart, not placed in regular rows; these are connected by fine laminate ridges and similar septa divide the angle between two adjacent ones; where these secondary ridges converge, there is another elevation, lower than the principal one, ordinarily quadrate in form, with the angles produced, sometimes triangular or pentagonal. The micropyle (68: 6) consists of about a dozen subequal, subcircular, polygonal cells arranged around a central point, with distinct though excessively delicate walls, and is situated at the bottom of a very

shallow pit which is about .04 mm. in diameter; the individual cells of the micropyle are usually more uniform and more circular than shown in the figure and are about .066 mm. in diameter, while the surrounding cells of the general surface are .044 mm. in diameter. Color of egg rather pale green, the elevated portions white. Height, 3 mm.; breadth, .56 mm.

Caterpillar. *First stage.* Head dark, shining, chestnut brown, ocular field black. Body very pale bluish white, uniformly, very minutely, and quite densely punctulated with brown spots; first thoracic segment with a dorsal shield of the color of the body, the papillae upon it blackish; the larger papillae of the body are of the body color, annulate with blackish, the smaller ones are brownish. The hairs have an annulate appearance due to the presence of excessively minute, regularly distributed, raised points as if for the support of hairs. Length, 1.1 mm.; breadth anteriorly, .3 mm.; posteriorly, .24 mm.; length of dorsal hairs, .047 mm.

Second stage. Brownish yellow or in summer greenish white, occasionally reddish. Length about 2 mm. (After Edwards).

Third stage. In spring, pale green, whitish dorsally, usually with a mediodorsal, often interrupted reddish stripe from the second thoracic to the sixth abdominal segments; in summer variable, buff or pale green, immaculate, the first thoracic segment brown, in some dorsally and laterally mottled with dark green and brown; occasionally vinous throughout or red with a white sub-stigmatal stripe; in autumn dull green, more or less marked with brown. Length about 3.5 mm. (After Edwards).

Fourth stage. Color variable as before. Length about 5 mm. (After Edwards).

Last stage (75: 29, 39, 40, 45). Head (79: 28) dark castaneous, broadly edged above and below with blackish; triangle tinged with blackish and edged distinctly with black; antennae pale; ocelli white in a black field; mouth parts reddish above, whitish below, the edge of the mandibles black.

Body almost white with a very pale roseate tinge; a narrow, faint, dusky, dorsal line from the second thoracic to the sixth abdominal segments; on either side of the first abdominal segment a laterodorsal triangular greenish patch having its base on the anterior edge of the segment; on the sides a series of very faint, greenish, oblique stripes, one to a segment; beneath, very pale greenish; wartlets white excepting on the laterodorsal patch of the first abdominal segment where they are black; hairs short, backward curved, white; spiracles white. Legs very pale yellowish; claws fuscous; prolegs very pale greenish. Length, 10.5 mm.; breadth, 3.25 mm.; length of long hairs, .24 mm.; of short ones, .05-.06 mm.

Chrysalis (84: 36, 43, 44). Upper surface light brownish yellow with a very faint yellowish fuscous dorsal line; prothorax infuscated and marked with blackish in the middle and at the sides. Mesothorax and first abdominal segment blackish at the dorsal line and with a small blackish fuscous spot next the wings; basal wing tubercle tipped with fuscous; third to the sixth abdominal segments with a transverse, blackish fuscous, lateral streak, increasing in size posteriorly; posterior segments a little infuscated. Under surface luteous, sparsely and faintly sprinkled with fuscous dots arranged in longitudinal rows. The raised lines which encase the body are dark brownish yellow; warts at base of hairs brownish, the hairs sometimes pale sometimes fuscous, a little longer on the front of prothorax than on the body generally. Spiracles white, bordered with luteous. Length, 7 mm.; height at thorax, 2.65 mm.; width at same, 2.25 mm.; height between thorax and abdomen, 2.5 mm.; width 2.75 mm.; height of abdomen, 4.45 mm.; width of same, 3.35 mm.; length of longer hairs, .19 mm.; of shorter hairs, .12-.14 mm.

Nomenclature. In the synonymy no attempt has here been made to consider the Californian forms, but only those in eastern America. These, it would seem, can fairly be reduced to three, there being scarcely any difference even in the south between those formerly considered as species, under the names *neglecta* and *pseudargiolus*, excepting in size and in the

slightly deeper tint of violet on the upper surface of the wings of the male *neglecta*; in these respects, also, as well as in such other slight differences as appear in comparison of the more typical examples, a complete and easy transition appears between the two. *Lucia* and *violacea* being but early and late members of the same brood there is also every gradation between them; but here the case is altered, for, first, there is the difference in the time of appearance often not found in the larger and smaller summer forms, and second, there is a corresponding segregation of forms, and a tendency of intergrades to resemble closely one or the other according to their time of eclosion. *Marginata* on the other hand seems to me only one of the stages in the intergrades between these two, possibly slightly more common than others, but not so in New England at least; on general considerations it should be looked for as the extremest type in the direction of *lucia* where *lucia* proper does not exist; but I do not see that we gain anything here by the use of a separate name. There is, however, an exception to be made in favor of the use of the subordinate term *nigra* for the dark dimorphic male of the race *violacea*.

Distribution (24:6). This delicate little butterfly is already known over a vast extent of territory. As already stated, it has various forms previously looked upon as distinct species, having distinctive geographical boundaries. It occurs in Alaska (Dall), but until recently—indeed since the printing of my map—has not been reported from any of the region between that and the lower Saskatchewan (Kirby), which is the more surprising as no inconsiderable collections have been obtained from there. Now we know of it from Telegraph Creek, Lat. 58° , Long. 131° (Dawson) and Cassiar trail, ten miles west of Dease Lake, Lat. $58^{\circ} 23'$ N., Long. $130^{\circ} 11'$ W. (Dawson). Otherwise its northern boundaries extend to not far north of the southern extremity of Hudson Bay; for it has been taken at Lake Winnipeg (Kennicutt, Scudder), at Martin's Falls, Albany River (British Museum), the southern coast of Labrador and Anticosti (Couper). The extreme western boundaries of this northern portion of its range are quite unknown; but it has been taken in Dakota, Montana and Nevada (Edwards) and is found in Victoria (Fletcher). Further south on the Pacific coast it assumes a distinctive form, formerly considered another species (*piasus*). Here it has been found from the southern boundary of California and Arizona to central California and according to some authors as far as Oregon. It is also reported from Mexico, as noted since our map was printed. East of this the species is found in all the Rocky Mountain region of Utah, Colorado and Wyoming. East of the Rocky Mountains it occurs in all the Gulf states excepting Florida, although it does not appear anywhere to touch the Gulf, but has been received from central Texas (Belfrage), is mentioned by Gosse from central Alabama, and figured by Abbot from Georgia. It occurs abundantly throughout New England.

The early spring form of the north, known as *lucia*, is confined to the northern portion of all this region, not occurring south of New England and New York, excepting in the extreme west, where it has been taken in northern Colorado. In the east it has been taken as far south as Yonkers and on Long Island, and in the west is not rare at Racine, Wis. These points indicate just about its extreme southern limits. It has not been reported in the west beyond Montana.

The form *piasus* is found in California, Arizona, and northern Sonora, but whether it extends into Nevada and Utah is as yet uncertain; it has not been reported from that region. Over the whole of the remaining territory covered by the species the forms *violacea* and *neglecta* occur and indeed extend a long way into the region appropriated by *lucia*; but the dark form of the male is peculiar to its southern limits. This last has not been found in Pennsylvania nor as far north as Dayton, Ohio. It is indeed not known north of Coalburgh, W. Va. (except that it is reported as taken by Graef in the vicinity of New York), nor in any part of Ohio and Illinois, but it has been obtained from Georgia, Virginia, western North Carolina, eastern Tennessee and even southern Colorado (Edwards).

In New England *lucia* has been everywhere found; it is extremely abundant in the northern half, not at all uncommon in the central portions, but comparatively rare in the south. *Violacea* is by no means uncommon, but having generally been mistaken for one of the other forms and so producing a confusion of statements, its exact distribution cannot be fully determined. It is, however, rather more common in the south than in the north, while *neglecta* is equally abundant throughout the district.

Haunts and abundance. Open deciduous woods, whether dry or swampy, are the favorite haunts of this butterfly, at the borders of which, or in their open shade, or by the road sides in their vicinity, it flutters in great numbers; for wherever found it appears to be abundant, possessing, as Edwards well puts it, the whole country. It settles about damp spots, and in the west is never found on the prairies, but at the bottom of the deep wooded ravines beside the streams.

Oviposition. The eggs are laid upon the buds, or the calyx of the flowers themselves if they have already opened, of the plant on which the larva feeds. As the flowers of these plants are always clustered, the eggs are the more difficult to discover because they are tucked in between the flowers often well out of sight. The eggs hatch in from four to eight days according to the season, Mr. Edwards says; mine, found in May by Miss Guild, hatched in six days.

Food plants of caterpillar. Eggs and caterpillars have been found on a large number of plants of very varied character; and as might be expected of a polyphagous caterpillar it will eat under stress not a few



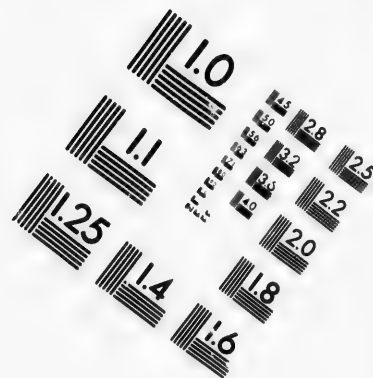
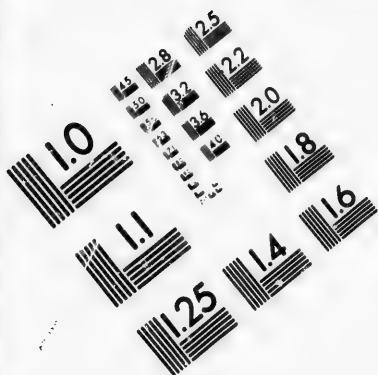
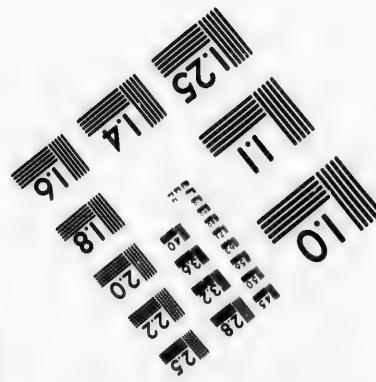
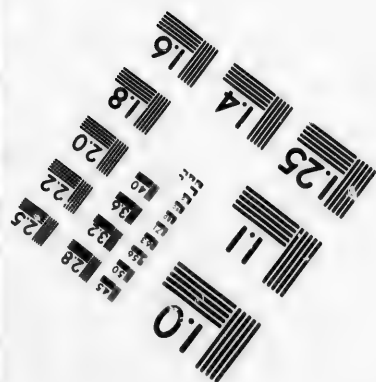
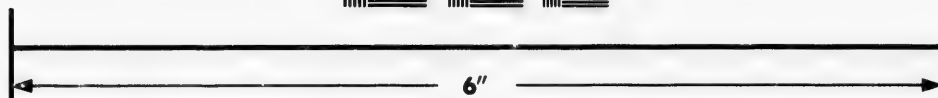
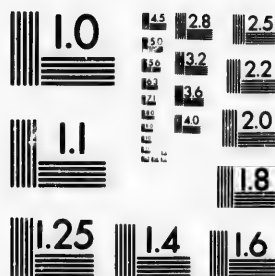


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other plants. Of those which are its proper food may be instanced *Cimicifuga racemosa*, according to Edwards (Ranunculaceae); sumach, on which Miss Morton has seen it lay eggs (Cruciferae); *Ceanothus americanus*, on which Mr. Mead found larvae (Rhamnaceae); *Aesculus californica*, according to Behr (Sapindaceae); *Erythrina herbacea* and *Apios tuberosa*, according to Abbot (Leguminosae); *Spiraea salicifolia*, on the blossoms of which Mr. P. S. Sprague found the full grown larva and about which I have often found the butterfly hovering; I have also obtained eggs from females enclosed over *Amelanchier canadensis*, on which they laid in preference to *Cornus*; but the young larvae would not touch the leaves and died (Rosaceae); *Cornus*, on which the larva was first found by Mr. Saunders and afterwards the eggs by Mr. Edwards, and on which the female was seen to lay eggs by Dr. Howe (Cornaceae); *Viburnum acerifolium*, on which Professor Comstock took the larvae (Caprifoliaceae); *Verbesina helianthoides* and *Actinomeris squarrosa*, on both of which, but especially on the last, Messrs. Mead and Edwards found eggs and larvae, and the cultivated *Dimorphantes manchuricus*, on which Mr. Edwards found a caterpillar (Compositae); *Vaccinium corymbosum*, on which Dr. Dimmock found and raised the larva, and perhaps another species of *Vaccinium* on which confined females lay freely for me, but the leaves of which the young larvae refused (Ericaceae); finally, *Ilex*, on which Abbot found it. But besides these it has been fed in confinement with more or less success on *Nasturtium*—Edwards (Cruciferae), *Rhamnus cathartica*—Scudder (Rhamnaceae), *Trifolium*—Edwards (Leguminosae), *Salix*—Saunders (Salicaceae), and *Begonia* and *Asclepias*—Edwards; making a total list of nineteen species of plants, of fifteen families,—a list much more extended and varied than that for its European congener. I have also seen the female hovering about alder as if seeking a place to lay eggs.

The extent of the list is no doubt due to the fact that the caterpillar feeds upon the buds and flowers of the plant; and as several successive broods appear, the same plant can hardly furnish blossoms at the proper season for such an unprincipled guest; the butterfly accordingly chooses a plant in or soon to be in flower. Mr. Edwards believes that its principal food in the spring is *Cornus*, in June *Cimicifuga*, and in the autumn *Actinomeris*; but this must of course vary according to the region in the wide territory over which the butterfly ranges.

Habits of the caterpillar. In emerging from the egg the caterpillar simply bites a circular opening through the top sufficient to make its escape, and rarely touches any more, though it sometimes eats a little larger hole than is really needed. Mr. Edwards, who has studied this species with great care and perseverance, gives full accounts of the habits of this caterpillar in various places, from which we put together the following extracts:—

As soon as hatched, the young larva cuts a minute hole, the diameter of its head, into the lower part of the unopened bud, just above the calyx, and feeds upon the filaments of the stamens. . . . As the larva feeds the [first thoracic] segment is pressed hard against the bud, so as to permit the utmost elongation of the neck. Thus it is enabled to eat out the contents of the bud, and only desists when there remains but the empty shell. When so engaged the anterior segments are curled up and the others rest on the stalk of the plant; but very small larvae rest wholly on the bud, curving around it. . . . After its first moult, it bores into the sides of the calyx, to get at the ovules; but as the flowers mature and the ovary hardens, the boring is from the top, inside the tube of the calyx, and follows the stalk of the pistil to the ovule. Finally, belated larvae are compelled to gnaw the seed vessel after it has become woody, and in several instances have been found eating the stem below the flower. It is not unusual for the larvae in confinement to eat of the white involucre of the flower, but I have never observed them eat of the leaves, even when no other food has been given them.

Dr. Dimmock, however, found that the larvae which he bred on *Vaccinium* ate away the surface of the leaf while young, but later ate the leaf entirely through; and the young larvae which I persuaded to eat buckthorn ate circular holes .25 mm. in diameter, in the upper surface of the leaf.

The behavior of the larvae in the presence of ants has for no species of *Lycaeninae* been so well and fully described as for this species by the same indefatigable observer, and the following account is accordingly extracted bodily from his different writings:—

I very soon noticed that ants also frequented the spikes, and supposed that the honey-sweet flowers drew them, but presently saw an ant running up and down the back of one of the larvae, drumming and gesticulating with its antennae, and was surprised to find that the larva, though feeding, did not seem in the least disturbed at the treatment, neither withdrawing its head from the bud nor wincing in the body. It evidently knew well who was treating it so familiarly. . . . The first day I had seen two species of ants engaged, each of medium size, but now I found a third and very small species operating in the same manner, and in one case six of these were busy over one larva. But the movements of all the species were similar. . . . They run over the body, caressing incessantly with the antennae, and undoubtedly with the object of persuading the larva to emit the fluid. . . . Much of the caressing is done about the anterior segments, and while the ants are . . . absent from the last segments, the tubes . . . are almost constantly exposed to full extent, and so remain, without contracting, until the ants come tumbling along in great excitement, and put either foot or antenna directly upon or close by the tubes, when these are instantly withdrawn. The ants pay no heed to the tubes, so far as touching them with intention, but at once turn to [the median gland], caress the back of that segment, put their mouths to the orifice, and show every sign of eager expectancy. . . . [With a lens] a movement will speedily be apparent, and there will protrude a dark green mammiloid membrane, from the top of which exudes a tiny drop of clear green fluid. This the ants drink greedily, two or three of them perhaps standing guard over it. The demonstrations of the ants are of the most gentle nature, caressing, entreating, and as the little creatures drink in the fluid, lifting their heads as if to prolong the swallowing, there is a manifest satisfaction and delectation that is amusing to see. They lick away the last trace and stroke the back of the segment, and wait to see if their coaxing avails anything. If not, they run about, . . . but presently all return, and the caressings go on as before. The intervals between the appearance of the globule vary with the conditions of the larva. If exhausted by yielding to the frequent solicitations, some minutes may elapse, and the tubes meanwhile will remain concealed; but a fresh larva requires little urging, and the mere intimation of the presence of an ant in the

vicinity is enough to cause the tubes to play rapidly, and one globule to follow another, sometimes without a retracting of the membrane, and before the near approach of the ants. I have counted six emissions in seventy-five seconds. The tubes are usually expanded when the ants are away from the last segments, and are retracted when they come near. I counted the length of these periods of complete and quiet expansion, ten, twenty, fifty and to eighty seconds, the period always ending with the approach of the ants. I experimented... placing larvae... upon stems of the growing plants, where the ants had access to them... As soon as the ants discovered [one of them], there was an immense excitement and a rush for the last larval segments. The larva forthwith relieved itself by the excretion of the fluid, and the tubes stood out with tops expanded between the pericosis. If I placed a fresh larva on a stem on which were no ants, there was no excitement in the larva, no appearance of the tubes, and no movement [in the median gland]. If ants were now transferred to the stem at once the larva changed its behavior.

It is only in the later stages that the ants attend the caterpillars, or any fluid is excreted from the median gland, though the organs are certainly present at an earlier stage. Mr. Edwards finds the attendance to be also confined to the summer broods of caterpillars, or at least to those on *Cimicifuga*, and judges that the caterpillars feeding on dogwood or *Actinomeris* can not exude so sweet a fluid, the flower of *Cimicifuga* being "of exceeding sweetness," while *Actinomeris* "has a dry flower, bitter to the taste."

Life history. This polymorphic insect is the first of our native butterflies to appear fresh from the chrysalis in spring. The earliest specimens—of the form *lucia*—gladden our eyes in Massachusetts about the middle of April, although often delayed a week by inclement weather; the earliest recorded date is that of April 14 (West Roxbury, Faxon). This form becomes abundant a week after its advent and continues so throughout the first half of May, when it begins rapidly to decrease and by the end of the month is very seldom seen. *C. p. violacea*, however, follows hard after it; this form—the *alter ego* of the preceding—makes its advent during the first week in May, occasionally not until the tenth or later, both sexes becoming abundant toward the end of the month, and it still remains upon the wing throughout June; one specimen was taken in Walpole, N. H. (Smith) as late as the 7th of July.

The appearance of this brood (*lucia-violacea*) is greatly delayed in northern New England. Thus in Maine its usual appearance is postponed until the middle of May, and in the White Mountains, where it is extremely abundant, females are rarely seen before June and in some years one may only find a dozen males in a day on the last of May. So, too, both here and in elevated localities farther south it is equally late in its disappearance, for male specimens of the form *lucia* (rubbed indeed) have been taken in Williamstown, Mass., as late as the middle of June (Scudder), in the White Mountains not uncommonly up to the 17th of the month (Scudder), and occasional specimens even on the 23d-24th (Sanborn), or faded, on the 26th (Morrison).

The earliest males of the next form, *C. p. neglecta*, appear at or shortly

before the middle of May, but they do not become abundant before the last week in the month; the first females appear about ten days later than the males but are still rare at the beginning of June, although they disappear toward the end of the month or early in July.

The earliest butterflies of the next brood, again *C. p. neglecta*, appear about the first of July and continue to emerge from the chrysalis until the first of August; they become abundant by the middle of July, although the males are often still greatly in excess in the latter half of the month, and in spite of their great delicacy these insects may still be seen in September. This brood does not seem to be so abundant as any of the preceding, and especially as the very first, the reason being that some of the earlier chrysalids do not give birth to the butterfly until the succeeding year; thus Dr. Dimmock obtained a caterpillar on *Vaccinium* which pupated on June 17th, and so should have emerged as a member of this July brood, but which did not give the butterfly (form *lucia*) until the winter (in a warm room). So Abbot in Georgia bred one of the forms in March from caterpillars which went into chrysalis the last of the preceding April. These facts with the relative numbers of the different broods and the experience of Mr. Edwards in West Virginia, to be mentioned, would seem to indicate that the spring brood is made up from chrysalids of all the broods of the preceding year.

I have given above the facts regarding the appearance of this insect as known to me in New England, and mainly as written many years ago, so as not to confuse the account by statements of the results of others outside of New England. But it cannot be said that the account formerly given by me (*Can. ent.*, viii: 61) is as there given wholly satisfactory, or accords fully with what is known elsewhere. That all the different forms of *Cyaniris*, in eastern America at least, belong to a single species is as good as proven; but that their relation to each other is as simple as I formerly supposed is by no means sure. If, as there regarded, *neglecta* is only and always the child of eggs of the same season, and the other forms of eggs of the preceding season, how does *neglecta* appear so early? There is a bare month between its first appearance and the first appearance of *lucia*. And yet the females never appear among the first, and if we are to look upon the earliest *neglecta* as born of eggs laid the same season then in a comparatively cool part of the year all the transformations must take place within three weeks. Now in West Virginia Mr. Edwards has found it to take more than seven. The only alternative that seems to be open is to regard at least the earlier *neglecta* as a part of the first brood, which then becomes trimorphic.

This is the view of it, essentially, which is taken by Mr. Edwards, who has had a far wider experience in rearing this insect than any one else. The first spring form in West Virginia (where *lucia* proper does not

occur) is followed, about the time when these are laying their eggs, by large examples of the summer form, the bulk of which have disappeared before the caterpillars from these eggs are mature; and by the time these large butterflies are quite gone appear the regular summer butterflies in direct descent from the early spring form. In accordance with this, as far as they go, are the observations of Dr. Howe of Yonkers, N. Y., who one year found the first male *lucia* on April 4, the first female April 12; while on the 22d of the month males of *neglecta* were taken; here only ten days intervened. It seems, therefore, far more probable that the successive apparition of *lucia*, *violacea* and *neglecta* before July in New England should be looked upon as the successive eclosion from wintering chrysalids of first one, then a second and finally a third form, all however to be properly regarded as a single brood. That there is more or less admixture of these forms should, under such circumstances, not be regarded as surprising, nor that intergrades should come between them; but the multiplication of names to designate these intergrades will only conceal the main point: that (if we regard the so-called *marginata* as *lucia*, as I believe we properly should), we have three irruptions of one brood at nearly equidistant times, in as many distinct guises, each of the later forms differing from that which precedes it in the lightness and poverty of the markings on the under surface of the wings. What the relation of these forms may be to those of the preceding year, is yet to be worked out. Exceedingly few specimens have been carried to maturity. The few facts known are these: that *lucia* has come from an early June caterpillar of the preceding year (Dimmock); that *violacea* has come from late summer caterpillars of the year before (Edwards); that *neglecta* (second brood) has come from caterpillars of *violacea* of the same year and from those of *neglecta* of the same year (Edwards); and finally that *neglecta* (first brood) has come from caterpillars of the same the preceding year (Edwards).

Occasionally specimens may be taken wholly out of season; thus a few years ago I took two female *violacea* at Waltham, Mass., on Aug. 3. Similar cases are known in almost all dimorphic butterflies.

How far this relation of the forms to each other may be modified in the north is yet to be determined. Jenner Weir says that Haydon found the species flying at Moose at the southern extremity of Hudson Bay from June to September and that it was even there double brooded; this last may fairly be doubted as he makes no reference to the presence there of other forms than *lucia* and *violacea*. In southern Labrador Couper found only *lucia* and *violacea*, which flew during June and July. Dr. Dawson took only specimens of *C. p. lucia* on the Liard, and early in June.

The females are laying eggs in New England about the middle of May and no doubt earlier and much later than this; and again in July.

Habits, flight, etc. Gosse, writing of these butterflies says (Can. nat., 123) :—

They are exceedingly playful; chasing each other through the air, and though often alighting on the ground, remaining scarcely an instant before they are in flight again, flitting about over one particular spot, which they seem reluctant to leave. Notwithstanding they are so restless, they are not difficult of approach, and are easily caught.

It flies with an uncertain, tremulous, wanton motion, never in a direct course, but hovering and quivering about one spot, never alighting without seeming to be very uncertain just where to go. If much alarmed it will move off more rapidly, but still with the same wayward motion, rarely rising as high as one's head. The beats of its wings are much less frequent and rapid than those of species of *Incisalia* among the Theclidi, in company with which it often occurs.

Its large wings and disproportionately slender body [says Edwards] give this species a slower and more tortuous and tremulous flight than any other of our eastern Lycaenidae. On the Kanawha River it is rather a common species during its season, the males somewhat frequenting the roads, especially where they skirt the edges of the woods, but very much preferring the brooksides in the forest. The females are rarely to be seen in the same localities, but are found in the more open woods among shrubs and low plants. [And in another place he says they are] conspicuous from their charming color, which, in the sunlight is intense [in the form *violacea*], as near as may be like *Salvia patens* among flowers.

They frequently congregate, especially the males before the females are out, in clusters around damp spots extracting the moisture from the ground, wings erect and tightly shut; putrid or excrementitious animal substances too, have great attractions for them. They are not at all timid, allowing one to approach close to them and when disturbed circling about the spot and speedily settling again. D'Urban tells of one that pitched on his hand and remained there for some time while he was in a canoe by the shore of a lake. They have been known to fly at night to the electric light!

When walking the wings are placed back to back, the hind pair not concealing the lowest submarginal spot of the fore wings; the antennae diverge at right angles and are bent slightly downward below the plane of the body; the fore legs—at least those of the male—seem to be used in some sense as feelers, their movements being at least twice as rapid as those of the other legs. When resting, the wings are held in the same position, but when moved by a breath of air, the fore wings droop a little so as to bring the costal edge of the secondaries almost to the upper median nervule; the antennae diverge at an angle of about 100° and viewed from above are straight; but from the side they are seen to curve forward considerably close to the base, their main portion being parallel with the body or raised at an angle of about 15° ; the club is curved very slightly upward. At more complete rest the fore wings droop, bringing the costal edges of all the wings together, and this position they frequently assume

when they are pinned but not set. The body is then bent in such a way that while the abdomen and lower edges of all the wings rest upon the surface, the thorax is elevated at an angle of 45° . The antennae are depressed so that they are on a line with the outer half of the costal margin of the fore wings; they divaricate at the same time at an angle of 80° or even as much as 110° .

Polymorphism. I have reserved for the present section a full account of the various forms assumed by this insect, although it has been necessary to state many of the facts in treating of the life history, and other topics. The species is spread over almost the entire North American continent. In the extreme north from Labrador to Alaska it is single brooded, but appears in two forms, lucia and violacea, differing largely in the heaviness of the markings of the under surface; whether one or the other form flies before the other, does not appear from any observations on the spot, as these are too meagre, but there is certainly nothing to show that it differs in this respect from what we find further south. To examine this we must confine our attention to the eastern half of the continent. Not far from latitude 45° N. two new phenomena appear: the butterfly becomes double brooded and trimorphic, and the third form with still lighter markings, of which the second brood is exclusively composed, appears also as a member of the first brood, the three forms succeeding each other at least within a month in the order of the heaviness of the dark markings of the under surface, viz.: lucia, violacea, neglecta. Confining our attention for the moment to the first brood, observations would seem to show that in the northern part of the belt of its trimorphism, the form neglecta is comparatively rare, but that in proceeding farther and farther south it becomes proportionally more and more numerous until, as about Albany, N. Y., it has altogether usurped in numerical importance the place formerly occupied by lucia, which entirely disappears at about the latitude of 41° , except (probably) in mountainous districts. At the same time the second brood, although apparently not more the product of neglecta than of violacea, becomes more abundant. We now reach another belt of country in which we find the butterfly again dimorphic in the first generation,—violacea and neglecta in the order of their appearance, and the summer generation as before. But we have not far to pass, say to 38° or 39° N., before we reach a new condition, in which the first form of the first generation becomes sexually dimorphic, the males appearing under two guises, one blue above, the normal violacea, the other dark brown, violacea-nigra; and this apparently continues as the condition of things as far toward the Gulf as the species extends. There can be little doubt that this succession of changes in passing from north southward is modified and interfered with to a considerable extent by the Alleghanies, and that on their flanks, in very near vicinity, we may find at least some exam-

ples of all these forms. In addition there are the following interesting points: Mr. Edwards finds that the neglecta of the first brood in West Virginia are larger than most of those of the second brood and gives to the former the distinctive special name pseudargiolus (proper); but inasmuch as some of the second brood are of the same size, and no genetic connection between large and large of the same year has been shown; and as, further to the north, all the larger neglecta so far as I have seen them come from the second brood, we do not seem warranted in applying a distinctive name. Mr. Edwards has further nominally segregated an intermediate type between lucia and violacea in the region where these exist together, calling it marginata, and by means of it attempts to show that lucia and violacea fly at the same time, which his own statistics show is not the case if "marginata" is looked upon, as I have always done, as only one phase in the variation of lucia, an opinion which is confirmed by finding in all the range of this polymorphic and especially topomorphic butterfly no place where one flies without the other, from Alaska and Vancouver to Labrador and southern New England.

In the extreme west, on the Pacific slope, we have a new form, piusius, most resembling neglecta, which so far as observations have gone appears to be single brooded in the north, double brooded in the south and to show no difference between the broods; as sharp a contrast as could well be found to the character of the species elsewhere; and it is the more strange as in Arizona (though, it should be noted, among the mountains) an ashen tinted form of violacea appears, to which Edwards has given the varietal name cinerea. This form piusius occurs as far north as central California. What is found to the north of that is not well known. At Vancouver, however, lucia and violacea are met with and violacea at least in Oregon, and it would seem as if, in the intervening area, not only lucia but also violacea must disappear and leave only the more weakly marked Pacific representative of neglecta as the remnant of the polymorphism of the first brood, and which does not become digoneutic until left in possession of the field.

It is Mr. Edwards's belief, apparently, that in the east at least the various forms perpetuate themselves; or at least that "nearly all the butterflies of the first generation must come in direct descent from their own form of the year before"; and that the progeny of the first generation of neglecta in West Virginia ("pseudargiolus") either give the same form the next year or the same large neglecta ("pseudargiolus") the same season. This does not seem to me to stand on so good apparent grounds as he would appear to think, for I much doubt whether even his quick discernment can distinguish in a dried and dead chrysalis the difference between the forms, and most especially between neglecta and "pseudargiolus." It seems far more probable that the three spring forms are made up indiscriminately of all the forms of the preceding year, as is apparently the case with Iphicli-

des ajax, which is homeomorphic in the same sense, though not to the same degree, as this species. But this plainly is a point which a careful multiplication of facts will alone clear up.

Miscellaneous. The androconia, of the form lucia at least, with which only I have experimented, are undoubtedly scent scales; for when the finger is rubbed over the upper surface of the fore wing of the male it will be found to have an odor, excessively faint indeed but perceptible, which I can only compare to the odor of crushed violet stems or perhaps to newly stirred earth in spring. No odor is perceptible when the same experiment is tried with the female.

Mr. Edwards tried the experiment of placing chrysalids of this species on ice, but unfortunately without success, as all died.

Parasites. Mr. Edwards has found four parasites attacking this insect. One of these is dipterous, *Exorista theclarum* (89:17, 19). "This deposits eggs on the skin of the larva while in the second larval stage," and the maggot pierces its way into the interior and comes out again when the caterpillar is full grown; of a dozen larvae sent him by Professor Comstock all but one were found to be infested with this parasite. Mr. Edwards in 1878 speaks of a second dipterous foe, but makes no mention of the same in his complete account in 1884; perhaps he has reference to *Syneches pusillus*, a fly belonging to the Empidæ, never known to be parasitic, but which emerged from a chrysalis of this species, whatever its larval habits may have been. Then he mentions three hymenopterous parasites, of which two are small. One of them, *Apanteles cyaniridis*, first identified as *A. congregatus*, deposits its eggs "singly within the very young larvae, and the grub eats its way out when the larva is but half grown, and proceeds to spin for itself a cylindrical cocoon of yellow silk, from which in a few days the perfect insect will break forth." Of the other minute parasite he tells us nothing, but he probably refers to *Hemiteles lyncenæ* described in the Appendix. The fourth parasite found by him was an ichneumon fly referred by Cresson to *Anomalon*. This attacks the larva "only in the last or perhaps the last two stages," and emerges from the chrysalis. Perhaps this is the same insect as *Angitia pseudargioli*, which I have obtained from this insect. Mr. Edwards does not think any of them very destructive as he has found the chrysalids remarkably free from parasites; and he relates an interesting story of how one of these enemies was driven away from its intended victim by the savage defence offered by an attendant ant.

Desiderata. One would suppose, from the amount of attention that has been paid this species, and the wealth of illustration that has been brought to its service by Mr. Edwards, that there would be little left to do. On the contrary the more facts he has brought forward, the more problems seem to arise requiring solution. The distribution of the butterfly over

so wide a range of country, involving very diverse climates and floras, with the affection of the caterpillars for the parts of the floral envelope rather than the leaves of its food plants, and the multifarious forms assumed both by the caterpillar and the imago, render the complete elucidation of its natural history one of the most perplexing and interesting problems open to the biologist. The difficulty attending the safe carriage of chrysalids of Lycaeninae through the winter is one great obstacle to success, which Mr. Edwards with all his attempts to simulate natural conditions, has been unable as yet to entirely overcome.

The relationship of each of the types that successively appear in any one region in a single season to each other, and to the same types the succeeding season, needs to be made out in scores of examples to learn the degree of dependence one has upon another. Particularly is it necessary to understand the connection of the earliest appearing summer types with the other. This is a bit of patient work in which any one disposed can bear his part, and it is, before all, the most essential point to be studied in any one locality. Particularly should it be followed out along the flanks of the Alleghanies from the Catskill region to West Virginia, that we may discover the exact changes which gradually come over the local history of the species from north to south. The food plants of the larva doubtless vary considerably in different regions, and therefore this also should be carefully looked into in many different stations. *Actinomeris* for instance, on which alone Mr. Edwards finds the later caterpillars, does not grow at all in New England, and must be replaced by something else. Those who doubt the intimate connection of "marginata" and *Lucia* for which I have here contended need also to investigate the seasonal relations of the supposed intermediate form to the others and its segregation as a distinct type. The difficulty of connecting the history of the Pacific form, *piasus*, with our own, renders it not impossible that notwithstanding its very close resemblance it may prove distinct. Fuller study of its history, and a knowledge of the *Cyanirides* of Oregon and Washington Territory are requisite. The species of attendant ants should be determined.

LIST OF ILLUSTRATIONS.—*CYANIRIS PSEUDARGIOLUS*.

General.

- Pl. 24, fig. 6. Distribution in North America.
89: 17. *Exorista theclarum*, a parasite;
head.

19. The same; wing.

Egg.

- Pl. 65, fig. 14. Oblique view.
15. Surface sculpture.
18. Colored, side view.
68: 6. Micropyle.

Caterpillar.

- Pl. 75, figs. 29, 30. Mature caterpillars.
40, 45. Same, dorsal view.

79: 28. Front view of head, stage v.

87: 14. Lateral caruncles, eighth abdominal segment.

19. Hinder extremity of body in outline, to show position of vesicle and caruncles.

Chrysalis.

Pl. 84, fig. 36, 43, 44. Side views.

Imago.

- Pl. 6, fig. 1 (*neglecta*). Male, both surfaces.
 3 (*violacea*). Male, both surfaces.
 4 (*neglecta*). Female, upper surface.
 5 (*violacea*). Female, upper surface.
 8 (*lucia*). Male, both surfaces.
 12 (*lucia*). Female, both surfaces.

Pl. 13, fig. 4 (*lucia*). Male, upper surface.7 (*lucia*). Side view, under surface.

34: 33, 34. Male abdominal appendages.

39: 16. Neuration.

46: 30. Androconium.

55: 5. Side view with head and appendages enlarged, and details of the structure of the legs.

61: 12. Front view of head, denuded.

NOMIADES HÜBNER.

Nomia Hübner, Syst. verz. bek. schmett.,

67 (1816).

Glaucopsyche Seudd., Syst. rev. Am. butt., 33

(1872).

Agrodictus Seudd., Proc. Amer. acad. arts. sc.,

x: 106 (1875).

(Not Agrodictus Hübner, 1825.)

Type.—*Pap. semitargus* Rott.

... those little bright-eyed things
 That float about the air on azure wings.

KEATS.—*Calidore*.

Imago (55: 6). Head small, covered densely with scales which form a tuft behind the antennae, and tufted, besides, with a shaggy mass of long, erect delicate hairs above and on the upper half of the front. Front nearly flat, above almost depressed, with two distant, slight, longitudinal grooves, below considerably tumid, considerably surpassing the front of the eyes, scarcely half so high again as broad, as broad as the eyes on a front view, the sides parallel, the upper border squarely docked and excised slightly at the angles, the lower rather broadly rounded, a little protuberant in the middle. Vertex very slightly protuberant in the middle, which portion is separated by a slender groove from the gradually rising elevations behind the antennae; separated from the occiput by a distinct, deep, transverse channel, the walls of which slope toward each other at a very little more than a right angle, the posterior the more abrupt. Eyes moderately large and full, very delicately, inconspicuously and sparsely pilose with very short hairs, scarcely visible above. Antennae inserted in the middle of the summit, separated by a space fully equal to the diameter of the antennal socket; considerably longer than the abdomen, consisting of about thirty-one joints, of which the last twelve form a club which seems to correspond in every respect with that of *Cyaniris*. Palpi slender, compressed, scarcely more than half as long again as the eye, the terminal joint scarcely one-third the length of the penultimate; the joints provided beneath with a heavy compressed fringe of very long, straight hairs, directed more and more forwards toward the tip, the few on the apical joint nearly recumbent.

Patagia very slender, scarcely arched or tumid, barely two and a half times longer than broad, tapering rather rapidly and regularly at first, the apical two-fifths produced as a long, equal, slender, straight, bluntly pointed lobe.

Fore wings (39: 19) fully two-thirds as long again as broad, the costal margin a little convex at the extreme base, beyond very slightly and regularly bowed, the outer angle but little rounded off; outer margin very slightly convex above, on the lower third receding with a little stronger curve, the general direction of the margin about 55° to 60° with the costal margin; inner border straight, scarcely concave in the middle, the outer angle somewhat rounded off. Costal nervure terminating just above the tip of the cell; subcostal nervure with three branches; first arising somewhat beyond the middle of the upper border of the cell; second about one-fourth the distance from this to the apex of the cell, the third as far before the apex of the cell as the basal separation of the first and second branches, its forking considerably beyond its

middle; cross veins closing the cell transverse, feeble on the inner, distinct on the outer halves; cell somewhat more than half as long as the wing and nearly four times as long as broad.

Hind wings with the costal margin having the basal third rather strongly convex, beyond slightly convex, the outer margin well rounded, rather full, though rounded at the upper angle, the inner margin convex, the outer angle broadly rounded. Submedian nervure terminating next the anal angle; internal nervure terminating near the middle of the inner border.

Androconia round oval, with a pedicel nearly one-half the length of the lamina.

Fore tibiae more than two-thirds the length of the hind tibiae and five-sixths the length of the tarsi; last joint of the fore tarsi like those of the other legs (♀), or provided with connate claws, resembling those of *Everes* (♂). Middle tibiae five-sixths the length of the hind tibiae, provided with short, tapering, scaly spurs. First joint of tarsi scarcely longer than the three succeeding joints combined, these diminishing in regular ratio, and the fifth scarcely longer than the third; all furnished beneath with short and rather slender, not very frequent spines, arranged on the first two or three joints in a triple, beyond in a double series, the apical spines of each joint larger than the others; claws small, pretty strongly falcate, especially on the basal half, tapering, moderately stout, finely pointed; paronychial double, the upper lobe forming a very slender, curved, pointed, chitinous claw, running beside and slenderer than the true claw, the lower an equal, blunt-tipped, incurved, elliptical lamina, two or three times as long as broad; pulvillus wanting.

Upper organ of male abdominal appendages mostly formed of two lunate and bullate alations, united above by their extremities and bearing beneath recurved, acicular, lateral arms. Clasp greatly elongated, depressed-laminate beyond the bullate base, apically truncate and bearing an incurved acicular tooth.

Mature caterpillar. Head rounded subquadrate, deeply cleft in the middle above, the triangle much more than half as high as the head, and higher than broad, separated from the cleft by a narrow space. Body arched longitudinally in a pretty regular curve with submoniliform segments, descending more abruptly in front than behind, the last two or three segments being somewhat depressed; the first thoracic and last abdominal segments are the longest and subequal, but also the smallest, as they are both considerably narrower than the body in the middle; viewed from above the body is regularly obovate and nearly four times longer than broad. The body is covered rather profusely with equally distributed, very small, daring, stellate papillae, each bearing a rather coarse and short, tapering, spiculliferous hair, and with a lesser number of simple minute papillae with similar but shorter hairs. Spiracles minute, circular, those of the seventh and eighth abdominal segments on an upward sloping line. Vesicle of the seventh abdominal segment present, but no caruncles on the eighth. Legs and prolegs as usual, each of the latter with from 16-18 slender, falciform hooklets.

This group of insects is fairly well represented throughout the north temperate zone, a number of species being peculiar to each continent. In both it spreads from ocean to ocean, and over about an equivalent latitudinal range. In North America it occupies a broad belt, extending, with some interruptions, from the Atlantic coast, between Newfoundland and Georgia, to the Pacific, from Southern California to Southern Alaska. It has never occurred in New England itself, but only upon its borders.

The butterflies are of a violet hue above, lustrous in the male, purplish in the female, and broadly (female) or very narrowly (male) bordered on the costal and outer margins with dark brown; beneath they are slate gray, with a sinuous, extra-mesial series of rather large, roundish, black

spots edged with white, a transverse dash at the tip of the cell and, near the base of the hind wing, parallel to the discal dash, a couple of round, black spots; the submarginal markings found in our other *Lycænidæ* are absent.

So far as their history is known, the butterflies are single brooded, flying principally in July and wintering as full grown caterpillars.* These feed upon the seeds, both immature and mature, of leguminous plants, such as *Astragalus*, *Trifolium*, *Coronilla*, *Onobrychis*, *Mellilotus*, *Anthyllis* and *Vicia*, but not being known to be provided with all the abdominal glands, some species at least lacking those of the eighth segment, it is uncertain whether or not they are attended by ants. The long life of the caterpillar, sometimes as much as ten months, is here the most remarkable feature.

The egg is pale green, almost white from the meshes of the raised tracery with which it is covered, flattened, turban-shaped, and laid in the crevices of flowers.

The caterpillar is of course onisciform, tapers more than ordinarily in front, has the terminal segments depressed, and is of a slender, oval shape, with well marked segments; it has a dorsal stripe and oblique lateral stripes, and in shape has been compared to the half of a grain of wheat.

The chrysalis is of the ordinary form, rather plump, with long wing-cases, of a drab color, with a dorsal and laterodorsal series of dark spots or interrupted lines. One observed in England by Mr. Buckler changed without spinning any silk whatever.

EXCURSUS XXXIV. — ORIGIN OF VARIETIES IN BUTTERFLIES, POSSIBLE AND PROBABLE.

... From every chink,
And secret corner, where they slept away
The wintry storms—or rising from their tombs,
To higher life—by myriads, forth at once,
Swarming they pour; of all the varied hues
Their beauty-beaming parent can disclose.
Ten thousand forms! ten thousand different tribes!
People the blaze.

THOMSON.—*Summer*.

PROBABLY there is no group of animals in which the study of variations can be pursued to as good advantage as butterflies. For here the opportunities for the action of natural selection are at the highest mark, and we see the result in the infinite variety and beauty of these delicious creatures. They live several separate lives in the course of one, and in each the forces of nature have new and distinct play. Many of them

*Boisduval, however, states that the European *N. cyllarus* winters as a chrysalis; and as he describes the latter, he must have known it at its proper season.

undergo the cycle of their changes more than once a year, and thus opportunities are not only multiplied but varied.

Ordinary variation, due to unknown or diverse causes, as well as that which springs from latitudinal range and distinct climatic influence, appears in butterflies as in other creatures. In these cases we suppose advantageous variations to be perpetuated and intensified by the survival of the fittest, through the laws of inheritance. By slow accretions, a species multiplies into varieties, each departing from the other and from the original type, until all become firmly fixed as species, again to undergo division. Now just as the climatic influences of latitude appear to be an important factor in the development of new forms, so the difference of the seasons may work similar alterations in double brooded butterflies; we have merely to suppose the zebra swallow-tail, for example, to hibernate exclusively in the imago state, to fix the variety *I. a. ajax* as the only form that will survive; on the other hand, let the insect hibernate as now in the chrysalis and be only single brooded, and this form would become extinct; suppose again both features to hold with different sets of individuals, gradually communicating this tendency in greater and greater force to their offspring, and we should behold the spring and summer varieties changed to separate species. This is one example of a mode in which seasonal dimorphism may become an originator of new forms. It is plain that entirely similar results may follow from unequal lethargy in one brood of caterpillars, such as we find in the fritillaries and the crescent spots.

Ordinary dimorphism again, or the appearance of different varieties in each brood, running through both sexes, must surely be a precursor of a division in the species; no doubt the change is gradual, so that centuries of direct experimentation would throw no light upon the change; but we have only to suppose each form breeding true to itself and the separation will be accomplished. In the case of the violet-tip, we have two strikingly different forms, which may be distinguished, not only by their coloring and markings, but even by the form of the wings and the sculpture of the hard parts of the abdomen; in fact, we have two forms, permanently distinct from each other, to which we cannot apply the name of species simply because we know they have the same immediate parentage; we can hardly doubt that the separation of this species is nearly accomplished.

The same may be affirmed of antigeny; we find melanic antigeny both partial and complete; in its partial condition in our spring azure it grows more and more nearly perfect as we pass southward; we see its form fixed in some species, and in others the melanic feature has been superinduced upon the opposite sex. The same is true of structural antigeny. Some species, which we can hardly doubt have had a common ancestor, scarcely

differ from each other excepting in the character of their antigenic peculiarities, and this accounts for the close resemblance of the females of allied species of skippers. Origin through antigeny probably occurs with other animals, but in butterflies it must be unusually common. So, too, with mimicry. The viceroys and the red-spotted purple are nearly identical in all their earlier stages, and yet utterly diverse in the perfect butterfly; both must have sprung from a common source, from which the viceroys have diverged through mimicry in its final stage.

Some naturalists would doubtless add here as a prime force in the origination of new forms, that presumed sphere of sexual selection which traces to it as a cause all those differences in color and pattern displayed by the two sexes; for it is a canon of their belief that most of the exquisite beauty of the wings of butterflies has arisen, as Darwin has shown good reason to be the case with the brilliant coloring of birds, through sexual selection, the handsomest winning the day. The application, however, of any such theory to butterflies is effectually estopped by the statement of two facts. First, that the latest experimental researches of physiology show that butterflies have no power of vision distinct and definite enough to enable them to distinguish the delicate patterns on the wings of their consorts, but only masses of color. Second, that both coloring and pattern as delicate and as minute as that of the winged butterfly is found in very many of their caterpillars, whose power of vision (through simple and not compound eyes) must be of an immensely inferior grade—probably one that can simply distinguish vaguely the near presence of objects through their perception of light and darkness.

Allusion has been made above to the differences observable in the male abdominal appendages of some varieties. Now as no two species of butterfly agree in the structure of these appendages it would appear as if these differences were of exceptional importance and had been given them, as Dufour has remarked, as "the guarantee, the safeguard of legitimate pairing." The differences are sometimes feeble, sometimes extraordinary; there is every grade between these extremes and the differences are very varied in character. Here then especially we have a foundation for that physiological isolation, not absolute but overpowering, which Romanes has so well urged as one of the principal elements in the origination of species, an isolation which has nearly or quite the same force as geographical segregation, of whose influence there is no doubt on any hand. The causes of this variation in these organs we can hardly conjecture; the amount is immensely greater than the difference in any other structural feature, as may be seen by our plates. Considering how closely these parts are connected with the generative functions, their importance as a basis for the origination of new forms and as a basis as well in the classification of forms already originated can surely not be doubted.

We have presented but few examples, but these will be sufficient to show in how many ways butterflies may vary and how these variations may be appropriated for the development of species, the distinctions becoming gradually intensified into complete and permanent diversity. This is natural selection. And by the avidity with which natural selection seizes every possible variation to produce new forms, one would fairly suppose that its constant action would lead to endless variety. Now if on this theory we should maintain that all existing forms of animal life have sprung from a few original sources, then we may fairly conclude that natural selection, by itself alone, would also lead to inextricable confusion, through which it would be impossible now to trace one thread of harmony. That it is not so, that the groupings and relations of structure among animals are clear to the human mind, that they present an orderly arrangement and a harmonious intercombination which appeals to his intellectual powers, is sufficient proof that natural selection, with all its wondrous and pervading power, acts under law, a law of evolution, which is no slave to the forces of nature, but brings them into subservience to its ends, a law which is working out the plans of a Supreme Intelligence, by ways which man may apprehend, but has not yet comprehended.

NOMIADES COUPERI.—The silver blue.*

Glaucopsyche couperi Grote, Bull. Buff. soc. nat. sc., 1: 185 (1873);—Scudd., *ibid.*, 1: 198 (1874).

Nomiades couperi Scudd., Can. ent., viii: 22-23 (1876).

Lycaena pembina Edw., Syn. N. Amer. butt., 37 (1871);—Strecker, Lep., 69, 84, pl. 10, figs. 10, 10, 11 (1874).

Glaucopsyche pembina Scudd., Syst. rev. Am. butt., 34 (1872).

Lycaena lygdamus Doubl., List. Lep. Brit. mus., ii: 45 (1847).

Lycaena afra Edw., Can. ent., xv: 211 (1883).

Figured by Glover, Ill. N. A. Lep., pl. H, fig. 6, ined.

(Not *Lyc. pembina* Edw., Proc. Acad. nat. sc. Phil. (1862); nor *Lyc. lygdamus* Doubl., Entom. (1841).)

A white-faced hornet hurtles by,
Lags a turquoise butterfly,—
One intent on prey and treasure,
One aloft on tides of pleasure!

MAURICE THOMPSON.—In *Haunts of Bess and Broom*.

On the first view to say, to swear, I love thee.

SHAKESPEARE.—*Midsummer-Night's Dream*.

Imago (14: 8, 10). Head covered with black scales, a narrow circle of white surrounding the eyes with the exception of the antennal spaces and connected across the lower part of the front by a white band; middle of the front and summit with a longitudinal row of very long, rather profuse, whitish hairs and with a few similar ones at the back of the sides arching forwards. Palpi, excepting apical joint, white at the sides, black above, with a long fringe of mingled black and white hair-like scales, the black preponderating apically, the white toward the base; apical joint blackish, white along the inside and at the tip; antennae blackish brown, the joints

* This name was given independently to this butterfly by Gosse and myself.

of the stem broadly annulated with white, tinged with yellowish so as sometimes to occupy the whole basal half of the joint, particularly on the basal half; club blackish, two or three apical joints excepting the last whitish above, the whole of the extreme under surface whitish. Tongue luteo-testaceous, a little infuscated laterally.

Thorax covered above with very long, silvery gray, profuse hairs, tinged more or less, and especially on the wing covers, with bluish; below gray with blackish and whitish scales and covered with rather long, brownish yellow hairs. Legs dull silvery gray, more or less marked minutely with blackish, the tibiae and tarsi more or less discolored above, the basal half of all but the basal joints of the latter blackish brown above. Spurs reddish at tip; spines blackish; claws reddish brown.

Wings bright lustrous, somewhat greenish violet, the veins with a hoary aspect; the costal border of fore wings very narrowly, especially at base, the outer border of both wings narrowly edged with black or blackish brown (δ); or of a darker more purplish violet, broadly bordered on the costal and outer margin with blackish brown, and having the tip of the cell marked in the fore wings by a narrow transverse blackish streak and the outer margin of both wings narrowly edged with blackish (φ). Costal edge of fore wings pale gray; inner border of hind wings pale. Fringe brownish fuscous on the basal, pale on the apical half.

Beneath uniform pale slate brown, almost wholly lustreless; the outer extremity of the cell is marked by a slender, transverse, bent, black streak, edged with white. *Fore wings* with a transverse row of six roundish black spots encircled with whitish, each occupying the width of an interspace, crossing the middle of the outer third of the wing, the lowermost spot, in the medio-submedian interspace, double; excepting the lowermost, which is just beneath the one above it, they are arranged in a curving row, the convexity outward, the outermost removed by its own width from a line connecting the extremes; the outer border is narrowly edged with a double bordering, the outer half dark brown, the inner half pale. Fringe brown, pale at extreme tip. *Hind wings* with a moderately small black spot encircled with white in the costo-subcostal interspace, just within the first divarication of the subcostal, and a smaller similar spot in the middle of the lower half of the cell; in the middle of the outer two-fifths of the wing there is a transverse tortuous row of eight roundish black spots encircled with white, that in the medio-submedian interspace double, that in the upper subcostal sometimes absent, nearly uniform in size, each occupying, with its border, from one-half to the whole of the width of an interspace, usually rather smaller than the corresponding spots on the fore wings; that in the upper subcostal interspace is situated in the middle of its interspace; that in the costo-subcostal is removed inwards by nearly its own width; the others form two similar and regular curves, the lower median forming a portion of either, the lower subcostal, lower median and submedio-internal being in one line, the others in another removed farther outward by nearly their own width; that in the lower median interspace is exactly beneath the middle of the middle median nervule; the outer margin and fringe are exactly as in the fore wing.

Abdomen above very dark brown with frequent long pale hairs and on the sides, and particularly at the tip of the abdominal joints, frequent pale scales; beneath very pale yellowish. Upper organ of male appendages (34:30, 31) with the apex of the lunate lateral alations roundly angled, the lateral arms rather short, roundly bent in the middle and tapering throughout. Clasps extending rather beyond the upper organ, viewed from the side somewhat bullate at base, tapering rapidly in the middle and produced to a slender tip; but seen from beneath they are depressed, equal throughout, and bear at the outer angle an acicular spine which lies along the truncate apex and is scarcely so long as the breadth of the same.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 5 mm.						
Length of fore wings.....	15.	15.	16.		15.	
antennae.....	7.5	7.5	8.			
hind tibiae and tarsi..	4.	4.	4.4			
fore tibiae and tarsi..	2.65	2.65				

Secondary sexual peculiarities. Besides the difference in the colors of the upper surface of the wings shown in the two sexes, the androconia (46:28), scattered over the upper surface of the wings, have a lamina, very regular short obovate in shape, the breadth about three-fourths the length, furnished with eight to ten parallel rows of bead-like spots and supported by a tapering pedicel nearly half as long as the lamina (represented too short on the plate); the latter about .00625 in breadth.

Caterpillar. *Last stage.* Head very small, brownish black. Body above delicate pink or flesh color, thickly covered with very short, fine, pink hairs scarcely visible without a magnifying glass, a brownish red dorsal line from [second thoracic] to terminal segments, widest and darkest on anterior segments. [First thoracic] segment pinkish anteriorly, with a patch of dull green behind just in front of the dark dorsal line on [next] segment. On each side are eight short brownish red lines, those on [thoracic] segments being placed nearly parallel with the dorsal line, those behind extending obliquely down the sides and edged above with dull white. A lateral line of dull white close to under surface extending on each side from [second thoracic] to terminal segments, fainter on anterior segments. Under surface greenish along the middle bordered with pink, which shades gradually into a pinkish red line, lying close to the white one which forms the boundary of upper surface; [legs] greenish faintly tipped with brown; prolegs green. [Length, 12.5 mm.]

Specimens less than half grown have a decidedly greenish tint, with a dark, reddish brown dorsal line; the lateral lines with that close to under surface are of a whitish green with a tinge of yellow; under surface dark green with a brownish red line underlying the greenish white one which borders the upper surface. Half grown specimens are pinkish with a tint of green, as they grow older they gradually assume the delicate pink of the full grown specimen. (Saunders).

Presumed to belong to this species.

Distribution (24:7). Little is yet known of the distribution of this charming butterfly, but it evidently belongs to the Canadian fauna and is undoubtedly more abundant in the northern than in the southern portions. Most of the localities from which it is reported lie near the annual isotherm of 35°. Passing from the east, westward, these are Carbonar Isl., Newfoundland (Gosse), Musquaro (61° W.), other parts of southern Labrador and Anticosti (Couper), Godbout River, mouth of the St. Lawrence, common (Corneau), Cacouna on the south side of the St. Lawrence (Saunders), Martin's Falls, Albany River (Brit. Mus.), Lake Superior (Geddes), Lake Winnipeg (Seudder), Brandon, Man. (Geddes), Bow River Country, Rocky Mountains (Geddes), upper Saskatchewan (Geddes), lower Saskatchewan (Seudder), Cassiar trail near Dease Lake, Lat. 58° 23' N., 130° 11' W. (Dawson) and the upper Liard River (Dawson).

It has never been taken in New England, or indeed in the United States, but the proximity of the locality Cacouna naturally leads us to suppose that it may occur in the extreme northern portions.

Food plant. The caterpillar, described above by Mr. Saunders, is only conjectured by him, but with strong probability, to belong to this species; it was found feeding on *Vicia cracca* Linn., one of the Leguminosae.

Life history. The memoranda at hand are too meagre to establish any

definite statement of the history of this insect; they are as follows: Dr. Dawson took specimens on the Cassiar trail in the high north on June 4, on the Liard River June 26, Couper in southern Labrador June 19 and 21, Corneau found them common at Godbout June 23, Couper, common and in good condition at Musquaro on July 4, Fletcher one rubbed specimen at Nepigon a day or two later, Gosse took them in Newfoundland, July 10, and at Cacouna Saunders took two specimens, one fair and one rubbed, besides half grown and mature caterpillars (presumably of this species) on July 19. With the exception of the first mentioned (in which there is no possibility of error) all lead to the presumption that the insect winters as a full grown larva, changes to chrysalis late in May or early in June, appears on the wing in the latter half of the month, flies for a full month, laying eggs during the greater part of that period, giving the best of the summer to the growth of the caterpillar.

Since writing the above Mr. Fletcher tells me that the seasons at Dease Lake (ten miles west of which Dawson's specimens were taken) are about the same as those of Ottawa; the same plants were in flower that June and upon the same dates in the two places, while the season of both places would be in advance of that of the Labrador coast or of Nepigon. Perhaps this sufficiently explains the difference in the dates, and should lead us to judge that the butterfly in the more favored localities normally flies the first of June.

Desiderata. This is one of our butterflies whose home is so far in the north that we may say that everything about its history and its early stages is needed information. Our knowledge of the larva is at best conjectural, and the dates of its seasons are only those of a few errant captures. The above statement of what is probable may form a ground work only for further enquiry. Haunts, character of flight and habits both of butterfly and caterpillar are quite unknown; any opportunity of obtaining the caterpillars on their natural food plants should be made use of for discovering what parasites it has, whether it is attended by ants, and whether it is possessed of both classes of abdominal glands.

LIST OF ILLUSTRATIONS.—*NOMIADES COUPERI*.

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| <i>General.</i> | | Pl. 34, figs. 30, 31. Male abdominal appendages. |
| Pl. 24, fig. 7. Distribution in North America, | | 39: 19. Neuraton. |
| <i>Imago.</i> | | 46: 28. Androconfium. |
| Pl. 14, fig. 8. Male, both surfaces. | | 55: 6. Side view with head and appendages |
| 10. Female, both surfaces. | | enlarged, and details of leg structure. |

RUSTICUS HÜBNER.

Rusticus Hübn., Tent. (1806). Type.—*Pap. argus* Linn.

I recognize
The moths, with that great overpoise of wings
Which makes a mystery of them how at all
They can stop flying: butterflies, that bear
Upon their blue wings such red embers round,
They seem to scorch the blue air into holes
Each flight they take.

E. B. BROWNING.—*Aurora Leigh*.

mag0 (55:7). Head small, densely covered with scales, which form a tuft behind the antennae; provided also sparsely on the upper half of the front with short, curving, erect hairs. Front flat, very slightly tumid beneath, scarcely surpassing the front of the eyes; above hollowed in the middle, with a broad longitudinal groove; scarcely half as high again as broad, fully as broad as the eyes; the sides parallel, the upper border squarely excised, its angles rather largely hollowed in front of the antennae; lower border strongly rounded. Vertex not tumid, well rounded longitudinally, rather suddenly and broadly elevated behind the antennae, as their support; separated from the occiput by a not very distinct, because tortuous, broad and not very deep transverse channel, the sides of which, about equally abrupt, form a right angle with each other; occiput longitudinally excised in the middle. Eyes not very large nor full, entirely naked. Antennae inserted rather in advance of the middle of the summit, separated by a space barely equalling the diameter of the first joint, scarcely longer than the abdomen, composed of about thirty-two joints, of which the last twelve or thirteen form the club, which is nearly three times broader than the stalk, four or five times longer than broad, very gradually increasing in diameter, the last two joints forming the bluntly rounded tip. Palpi slender, compressed, nearly, if not quite, twice as long as the eye, the terminal joint very slender, scarcely more than one-third as long as the middle joint and clothed only with recumbent scales; other joints heavily scaled and also thinly fringed with rather long, forward reaching, erect, coarse hairs, narrowly compressed in a vertical plane.

Patagia scarcely tumid, a little arched, slender, about two and a half times longer than broad, the inner border considerably curved, the outer bent, tapering considerably, but the apical two-fifths equal, moderately slender, bent a very little outward and bluntly rounded at tip.

Fore wings (39:18) fully three-fourths as long again as broad, the costal margin strongly and rather abruptly convex at base, beyond nearly straight, scarcely convex, the extreme tip sloping downward; outer margin rather strongly and regularly convex, its general direction at an angle of about 55° with the middle of the costal border, the upper angle abrupt but rounded, the lower well rounded off, inner margin straight. Costal nervure terminating a little before the tip of the cell; subcostal with three superior branches; first arising a little beyond the middle of the cell, second at nearly one-third the distance from this to the apex of the cell, the third as in *Nomlades*, but forking before the middle of its course; veins closing the cell excessively feeble throughout, bent at a slight angle; cell somewhat more than half as long as the wing, and fully four times as long as broad.

Hind wings with the costal margin a little convex on the basal third, beyond scarcely convex, the outer margin well rounded, fullest in the anterior half and especially in the ♀, the inner border a little convex, the apical half slightly excised, the angle very broad, rounded off. Submedian nervure terminating at the anal angle; internal nervure terminating a little beyond the middle of the inner border.

Androconia flattened, oval in shape, almost alike at the two ends, the pedicel scarcely tapering.

Fore tibiae a little more than five-eighths the length of the hind tibiae, the tarsi either scarcely (δ) or nearly one-third (♀) longer than the tibiae, but tibiae and tarsi combined about equal in the two sexes; apical appendages of the last tarsal joint either like those of the other legs (♀); or the claws connate, forming a single, conical, appressed hook, broad at base, scarcely curving, longer than normal, and the paronychial and pulvillus wanting (δ); in other respects the fore legs do not differ materially in structure from the other legs, but they are shorter, not quite so crowded with spines, those of the tibiae being very few and scattered, and the tibial spurs, although not small, are naked. Middle tibiae scarcely four-fifths the length of the hind tibiae and armed beneath with a double row of short, very distant, delicate spines, and at the tip with a pair of not very long, scaly spurs. First joint of tarsi nearly equalling all the rest combined, the second, third and fourth diminishing regularly, the fifth scarcely so long as the second, all furnished beneath with a mass of long and slender, crowded, tapering spines, mostly confined to two rows beyond the basal joint, the apical ones of each joint longer, spur-like; claws small, moderately slender, rather strongly, but not regularly, curved, being bent before the middle and slightly hooked at the tip, tapering, finely pointed, and having at the base a large, rounded, slightly produced, compressed lobe; paronychial double, the superior lobe nearly as long as the claw, tapering, slender, but little curved, the inferior nearly as long and slender, nearly equal, bluntly pointed, curving a little inward and strongly forward; pulvillus wanting.

Male abdominal appendages with the lateral alations extended backward as parallel, tapering spines, slightly bullate at base, the lateral arms excessively slender, long and delicate, bent about the middle. Clasps of unusual breadth and uniformity, terminating in a very blunt angle and a double point.

Egg. Twice as broad as high, flattened, turban-shaped, the upper surface almost perfectly flat and extending far toward the strongly convex sides; lower surface scarcely arched; sides covered with a tracery of subtriangular or triangular cells with compressed, equal walls, considerably thickened but scarcely elevated at the points of convergence of the lines of the triangles. Above, the cells are smaller and more rounded (subcircular or oval), the walls thicker and lower and entirely uniform in height, with no such enlargements at the junction of lines. The micropyle rosette is a sunken basin of entirely similar cells, but on a diminutive scale and forming only a delicate tracery.

Caterpillar at birth. Head generally wholly exerted, deeply cleft posteriorly between the hemispheres, a little angulate at its widest part; frontal triangle very large, considerably more than half as high as the head and much higher than broad. Body triangularly subcylindrical, the dorsal region narrowly depressed, the first thoracic segment more arched, the last abdominal segment greatly flattened, with a transversely oval, sunken, central, chitinous area. Legs rather long and slender with slender, curving, pointed claws. Whole surface of the body scabrous with minute stellate papillae. The following is the arrangement of papillae and annuli in which all the serial hairs are blunt tipped: first thoracic segment with a strongly arcuate series of eight or nine papillae, bearing forward-curving, spiciferous hairs; on either side an oblique row of three similar papillae, and, enclosed posteriorly in the arcuate embrace of the first mentioned, a number of larger and smaller chitinous annuli in three short, transverse rows, the hindmost containing also a pair of laterodorsal, hair-emitting papillae. Second thoracic segment with a pair of laterodorsal papillae, anteriorly placed and bearing forward-curving, long hairs, a similar lateral pair, and a single anterior infra-lateral circle besides the appendages to be mentioned. The eighth abdominal segment has a conspicuous, strongly arcuate series of numerous papillae, the concavity forwards, the papillae irregularly ranged and each bearing a backward sweeping hair. Common to many segments are the following: a laterodorsal series of closely anterior, small annuli from the third thoracic to the seventh abdominal segments inclusive, high, central, laterodorsal papillae, with a very long, backward sweeping and curving hair on the second thoracic to the eighth abdominal segments, those on the thoracic seg-

ments more widely separated than on the abdominal; small papillae with comparatively short, backward directed, subrecumbent hairs just behind the preceding, on the second thoracic to the sixth abdominal segments; next, a lateral series of anterior, central, large annuli (becoming infralateral on the third thoracic, high supralateral on the sixth to eighth abdominal, and very large on the sixth abdominal segments) extending from the second thoracic to the eighth abdominal segments; an infralateral series of smaller circlelets on the first to seventh, but becoming larger and lateral on the sixth to seventh abdominal segments; a laterostigmatal series of minute annuli, two to a segment, the anterior the lower, on the first six abdominal segments, found also, but carried higher up and the hinder greatly enlarged, on the seventh abdominal segment; also on the second thoracic segment, but at same level and the anterior one only; finally, a ventrostigmatal series of three high papillae, each bearing a hair, placed in an oblique series: the anterior lowest and bearing a comparatively short, straight, granulated hair, directed outward and a little forward; the middle a larger, straight, granulated hair directed outward; and the posterior the shortest, a gently curved, gently clubbed, smooth hair, directed backward and outward. Plate 71, fig. 4 is wrong in making the infralateral and laterostigmatal lenticles into short bristle-bearing papillae.

Mature caterpillar. Head well rounded, higher than broad, deeply and broadly cleft above between the hemispheres, so as to barely escape reaching the summit of the frontal triangle; the latter half as high as the head and higher than broad; ocelli composed of five equal, equidistant, roundish oval lenticles forming the quadrant of a circle with a sixth similar one at its centre.

Body high, teetiform, the summit depressed in a narrow dorsal area, which broadens a little on the thoracic segments; anteriorly it falls off rapidly, and posteriorly the body becomes depressed, and the last segment well rounded. Viewed laterally, the summits of the segments are prominently moniliform, with distinct, elevated, subdorsal papillae in the stages following the first, which are lost in the last stage, when the body is covered with a promiscuous assemblage of equally and rather closely distributed, very short and unequal, pointed hairs, arising from small, stellate papillae. A transverse slit in the middle of the dorsum of the seventh abdominal segment appears in the third stage, but apparently the caruncles of the eighth segment (86: 14) do not appear until the fourth stage, when they are wider apart than in *Cyaniris*. Spiracles exceedingly minute, slightly oval.

Chrysalis. Long and slender, being about three times as long as broad; viewed from above the sides are straight and slightly divergent along the line of the wings, beyond which the abdomen forms a regular elliptic curve; the basal wing tubercle is tolerably prominent, but well rounded, the prothorax being considerably narrower than the body at the wing-base and in front roundly and shallowly emarginate. Viewed from the side the thorax is highest a little behind the middle of the mesothorax, behind which it is almost level, and in front of which it slopes regularly and rapidly to the base of the antennae. Abdomen but little higher than the thorax, highest at the third segment, very broadly arched, but at last falling off rapidly behind exactly as in *Cyaniris*; transversely it is cylindrical, but the sides of the mesothorax slope toward each other at an angle of about 85°, the summit well rounded. Tongue exposed three-fifths way to tip of antennae. Body covered with a reticulation of raised lines much as in *Cyaniris*, but more delicate and the hairs much shorter and blunt tipped. Hooklets of cremaster with a slender, gently arcuate, rather long stalk, rapidly expanding and curved over into a rather tight roll at tip, the outer apical angles produced into a tiny claw.

Distribution. This genus is widely distributed with numerous members over the north temperate zone of both hemispheres, but within somewhat different climatic limitations; in the Old World and in the western half of the New World, it inhabits warmer regions than in eastern North

America, for in all it occurs between Lat. 40° and 60°, a region which represents a much colder climate in eastern North America than in the other regions mentioned;* indeed in California it probably descends at least to the 35th parallel. According to Koeh it is also found in southern Australia, which would accord with its distribution in the northern half of the Old World, or better, with that of the species found in western North America. Only a single species occurs in eastern North America, which has been found only upon the confines of New England and northward.

Appearance. The butterflies are deep violet above, in the male uniform, in the female heavily bordered with dark brown on the costal margin of both wings and on the outer border of the front pair; the hind wings of the female have a marginal series of black spots surmounted by red. Beneath, the wings of both sexes are pale gray with a double marginal series of dark spots, conspicuously pupilled with red, especially on the hind pair; there is a dash at the tip of the cell, and on the hind wings three small, dark spots next the base, and a sinuous series of dark roundish markings in the middle of the outer half.

Life history. Our eastern species at least is double brooded, and Meyer Dür gives the same account of the European forms. Prittwitz, however, states that the European butterflies are single brooded and so do others. Our species appears in June and the last of July; but in what condition the insects hibernate is unknown. It is stated by Hellins that the European *R. aegon* winters as an egg, but Zeller and Hellins both found that *R. astrarche* wintered as a larva partly grown, and Hellins carried also larvae of *R. icarus* and *bellargus* through the winter. The butterflies mingle in flocks, and rest with partially expanded wings. The larvae feed on Leguminosae; our American species have been found on *Hosackia*, *Lupinus* and *Astragalus*; the European on no less than a dozen genera of leguminous plants, besides *Helianthemum*, *Geranium*, *Erodium*, *Fragaria*, *Sedum*, and even *Erica*, *Plantago*, *Stachys* and *Thymus*. The transformations of our eastern species is pretty well known; that of one of the western species has been described by Edwards, and those of several of the European species are known.

Caterpillars and ants. The caterpillars are provided with the median gland and lateral caruncles of the hinder end of the body and are attended by ants who caress them to procure the sweets from the gland. Both sets of abdominal glands are certainly present in *R. aegon*, but Zeller could not discover those of the eighth segment in *R. astrarche*. Aurivillius states that he once found six pupae of the European *R. argus* under the bark of a pine inhabited by *Lasius niger* and suggests that it is because of a similar commensalism in these species. The attendance of

* Although it occurs in the Alps up to about 6000 feet.

ants has been observed with both of our species whose transformations are known. Edwards made the following experiments on the western species, *R. melissa*:—

On June 9 I introduced a small ant to this larva, which was confined in a glass tube. The ant soon discovered the larva, and ran about it in great excitement, caressing it with its antennae. Immediately the tubes which I had not hitherto seen, began to play, and one or the other, or both together, were exposed for some minutes, and indeed so long as the ant was near. Sometimes the tubes were fully protruded, with the tentacles expanded, at other times were partially withdrawn, in that case coming together in a pencil just as has been observed in *pseudargiolus*. . . . The ant always ended its caresses by putting its mouth to the orifice [on the seventh abdominal segment], and by its motions evidently found the fluid it sought. Next day I turned in two ants at the same time, and of a larger species. They ran about the glass as if alarmed at finding themselves in confinement, and accidentally one soon touched the larva. At once a drop of green fluid bubbled up from [the orifice] before the tubes made any movement. The ant saw it and rushed to it, and then the tubes began to play. They had been quiet for fully five minutes before, and while I was sitting by, but now they played intermittently for two or three minutes, the tentacles fully expanding and then partly retreating. The ants drank of the drops four times and then desisted, running about the glass again. I let them out and introduced one of the small ants, the same species as that experimented with the day before. Almost at once it found the larva, caressed it gently, and was favored with the coveted nectar, the tubes all the time in motion. On the 12th, larva now mature, I introduced an ant. As usual, as soon as the manipulations began, the tubes began to play, and presently a large drop issued. . . . In ten seconds, by the watch, another followed, but for some time after there was no more, though the ant begged urgently for it. The ant left [the orifice], and ran up and down the body of the larva, caressing the anterior segments, and then returned to [the orifice] and begged again. This was repeated several times, but the larva was obdurate. This larva was near pupation, and was probably exhausted. The solicitations are made by the antennae alone, which fly about, drumming here, there and everywhere, the ant manifesting great excitement. I was observing ants in tubes with *pseudargiolus* at this same time, and the behavior of the two species was identical. (Papilio, iv: 92-93.)

Pupation. Boisduval states that when *R. bellargus* seeks to change to chrysalis it hides itself under the twigs of plants in such a way that the chrysalis is almost half buried in the ground. Zeller says that the larva of *R. astrarche* creeps about restlessly when the time for pupation arrives, and he found it hard to satisfy its choice with dry leaves and stems and crumpled paper among the living plants on which it had been feeding. Most of them changed on the surface of the ground without spinning; but some spun in the normal manner, and one "on a willow leaf between stems of *Artemisia*, which it had drawn together with some transverse threads, forming, as it were, the rudiments of a cocoon." So, too, Helins found one of the pupae of *R. aegon* which he reared, lying "amongst a few loose threads at the very bottom of the stems and partly in the earth"; while those of *R. astrarche* were "in nearly perpendicular positions, amongst, and slightly attached to, the stems of the *Helianthemum* [on which it had fed] by a few silk threads near the ground."

Early stages. The eggs are white, tiarate, flattened above and below,

and covered with a delicate tracery of raised lines having a kind of wheel pattern.

The caterpillars are green, with or without a dorsal stripe, and with faint, oblique, lateral lines, the head capable of being extended to a great length.

The chrysalids are long and slender, almost uniform green, with a full, plump abdomen, covered with a very delicate reticulation of raised lines.

EXCURSUS XXXV. — THE FRIENDS AND ASSOCIATES OF CATERPILLARS.

Brown and furry,
Caterpillar in a hurry,
Take your walk
To the shady leaf, or stalk,
Or what not,
Which may be the chosen spot.
No toad spy you,
Hovering bird of prey pass by you;
Spin and dle,
To live again a butterfly.

CHRISTINA ROSSETTI.

ONE of the most surprising statements which have been made regarding the caterpillars of butterflies is that they are sometimes accompanied by ants, which seem to guard them with great jealousy, running about them with nervous activity, and rushing with open jaws at any creature that approaches. This phenomenon, first observed more than a century ago, has been repeatedly witnessed by others, but owing to the fact that the caterpillars in question are very small, usually of the color of the leaf or flower upon which they may be feeding, slow in movement and of a flattened form, they are among the least known of our caterpillars and rarely are seen by the casual observer. For the only caterpillars which are thus accompanied are, as far as known, those which belong to the subfamily of the *Lyceninae*, and indeed to the tribe of *Lycenidi* or blues, minute butterflies whose caterpillars rarely attain a length of an inch. The cause of this friendship and association is not far to seek, for a slight observation of the action of the ants will show that they have a reason for their devotion to the caterpillars. They tend these as they tend plant lice, because each of them has the power of exuding, from special glands at the extremity of the body, a droplet of fluid having a saccharine character, and thus attractive to ants, whose fondness for sweet things is well known to every housekeeper. In the butterfly caterpillars, as has been detailed elsewhere in the body of this work, this gland is situated in the middle of the body on the seventh abdominal segment, and now and then, at the solicitation of the ants, by the stooping of their antennae, is evaginated and a droplet of fluid exposed, which the ants greedily lap up.

Now, although the only caterpillars attended by ants belong to the

blue butterflies, the gland which secretes the sugary fluid is not confined to the caterpillars of these butterflies, but is also found in many of their immediate allies, namely, in most of the hair-streaks or Theclidi, and in one at least of the coppers, viz., *Tomares ballus* of Europe. Two explanations readily offer themselves: one, that in caterpillars so little known as are these, it may well be true that the association of the ants with the caterpillars has escaped notice; or, on the other hand, that in these instances the glands secrete a fluid which has no saccharine ingredients. The advantage that it may be to the caterpillar to secrete a sweet fluid attractive to ants is obvious, since the ants undoubtedly keep off many ichneumon flies and other enemies of the caterpillar, and the mutual benefit conferred by ant and caterpillar is unquestionable. It is doubtful if in the other cases the gland ever secretes a fluid having an offensive quality which might equally serve as a protection against intruders, since this means of defence is probably found, in caterpillars of this group, in organs of a very different character upon the succeeding abdominal segment, and it is hardly to be presumed that two organs, distinct in their position and structure, should arise in one and the same animal for precisely the same object. The use, therefore, of the median gland presumably not possessing a saccharine character is very problematical.

It should not be overlooked in connection with this subject that these caterpillars are themselves fond of saccharine matters. They, and only they, of all our butterfly caterpillars, attack flowers where honey is secreted, and there is at least one form described in this work which has come to have an entirely carnivorous diet, feeding upon plant lice bodily for their juices, very likely for the same reason that the ants seek their secreted fluids in detail. So, too, and possibly for the same reason, these creatures not unfrequently show a cannibalistic tendency, feeding upon the bodies of their own brethren when they are in a helpless condition, as previous to pupation. All these subjects are closely related to one another, and need to be investigated more carefully in order to a complete solution of their meaning.

It is a curious thing that among the *Lycaenidi* these glands are found on some species while not found upon others closely allied; their occurrence in many members of the other two tribes of the *Lycaeninae*, together with the impossibility of their independent origination in different genera render it probable that these glands first arose as long ago as before the differentiation of the three tribes of *Lycaeninae*. The brotherhood of the ants and the caterpillars may therefore be of great antiquity.

. See especially a paper by Mr. W. H. Edwards, on the larvae of *Lyc. pseudargiolus* and attendant ants (*Can. ent.*, x: 131-136) and his account of the same insect in his *Butterflies of North America*, Vol. II.

RUSTICUS SCUDDERII.—The pearl studded violet.

Lycaena scudderii Edw., Proc. Acad. nat. sc. Philad., 1861, 164; 1862, 225;—Morr., Syn. Lep. N. Amer., 329-330, 352 (1862);—Streck., Lep., 87 (1874);—Möschl., Stett. ent. zeit., xxxv: 155-156 (1874);—Saund., Can. ent., x: 14 (1878);—Middl., Rep. Ill. ins., x: 95 (1881);—French, Butt. east. U. S., 285-286 (1886).
Cupido scudderii Kirtb., Syn. Catal. Lep., 358 (1871).

Plebeius scudderii Kirtb., Ibid., 653 (1871).
Lycaeides scudderii Scudd., Syst. rev. Am. butt., 33 (1872).

Rusticus scudderii Scudd., Bull. Buff. soc. nat. sc., III: 122 (1876); Psyche, v: 13 (1888).

Lycaena aster Edw., Can. ent., xiv: 104-105 (1882).

Figured by Glover, Ill. N. A. Lep., pl. 38 fig. 10; pl. I, fig. 9.

A butterfly (but newly born)
 Sate proudly perking on a rose;
 With pert conceit his bosom glows,
 His wings (all glorious to behold)
 Bedropt with azure, jet and gold,
 Wide he displays; the spangled dew
 Reflects his eyes and various hue.

JOHN GAY.—*The Butterfly and the Snail.*

O, how thy worth with manners may I sing,
 When thou art all the better part of me?
 What can mine own praise to mine own self bring?
 And what is't but mine own when I praise thee?

SHAKESPEARE.—*Sonnet.*

Imago (6: 6, 7).—Head covered above with black scales; a broad circlet of silvery white scales encircles most of the eyes, running from the immediate front of the antennae nearly to their back, but separated from them by its own width; the lower portion of the front is also bordered with white and the sides behind the eyes are black, more or less profusely sprinkled with white; front between and above the white markings black, with a band of bluish scales and pale blue hairs running down the middle and reaching nearly to the back of the head where the hairs become whitish; palpi white at base, with an inferior fringe on the first and second joints of mingled black and white, the upper surface, apical half of the lower surface and apex of outer surface of the second joint, blackish; last joint blackish, whitish at extreme tip. Antennae black, annulated distinctly at the base of each joint of the stem with white, more heavily beneath than above; club above black, the last three or four joints mostly whitish, below fusco-luteous, brighter toward tip, darker toward base and often marked to some extent, especially toward base, with white. Tongue pale fusco-luteous throughout.

Prothorax covered with black scales and longer bluish hairs. Thorax covered with recumbent black scales and long bluish hairs; patagia with many steel gray scales, especially exteriorly, concealed in great measure by long bluish hairs; below covered with white scales and rather short white hairs with a bluish tinge. Legs covered with silvery white scales and hairs, the base of the tarsal joints marked rather heavily above with blackish; spurs covered with white scales to their reddish yellow tip. Spines black; spurs brownish yellow, dusky toward the base.

Wings above rather bright, uniform, lustrous, purplish violet (♂); or with the same color, having a metallic tinge, confined to the basal three-fourths of the lower two-thirds of the wing, the costal border as far as the upper limits of the cell and the outer margin for more than the width of an interspace being dark slate brown; sometimes the brown encroaches still more on the violet, and the apex of the cell, particularly in the fore wings, is marked by a dusky line, while the nervules crossing the violaceous space are also brownish; there is a submarginal series of roundish dark brown spots in the interspaces of the hind wings, which are more or less surmounted and embraced, especially in the median interspaces, by orange lunules, themselves edged above faintly with black (♀). In both sexes, the costal edge of the fore wings

is white and the outer border of both wings distinctly, but narrowly, the apical portion of the costal margin of fore wings very narrowly, and the costal border of the hind wings as far as the costal nervule, margined with blackish brown; inner margin of hind wings fuscous, heavily decked with pale blue; fringe very pale bluish white, infuscated at the extreme base.

Beneath pale hoary slate gray. *Fore wings* with the apex of the cell marked by a pretty large transverse black bar, attenuated below, encircled with white; midway between this and the outer border is a somewhat sinuous or bent series of six moderately large, subequal, black spots encircled with white, subparallel to the outer border; the upper one is round, the next three roundish or rounded triangular, the fifth generally the same, but sometimes extended diagonally to the lower median interspace toward the base of the wing; the lowermost sometimes roundish but usually a little linear, having the direction of the bar at apex of the cell; the second spot is usually a little nearer the outer border than the first or third, but sometimes is on a line with them and the series is then bent at the third spot; a little nearer the outer border than this extra-mesial row of spots is a series of rather indistinct, dark brown lunules, opening outwards parallel to the outer border, surmounted faintly by whitish and surmounting very pale orange spots, sometimes almost entirely pale, bordered exteriorly, narrowly and faintly with dusky; the outer margin is narrowly edged with blackish, sometimes enlarging into minute spots at the nervure tips. Fringe as above. *Hind wings* with a transverse curved series of small, roundish, black spots encircled with white in the middle of the base of the wings, in the costo-subcostal interspace, in the middle of the lower half of the cell, in the medio-submedian and the submedio-internal interspaces; the tip of the cell is marked as in the fore wings but more narrowly; beyond is a transverse series of eight roundish black spots, encircled narrowly with whitish, arranged in a double curving row; above the lower median interspace a very strongly curving row and below one rather less so, each with its convexity outward; the spots in the costo-subcostal, the lower median and the medio-submedian interspaces are in nearly or quite the same line as the bar at the tip of the cell; the first to third spots are in a very slightly curved row and the third to sixth are in a similar row at nearly right angles; that in the lower subcostal interspace is at about two-fifths of the distance from the tip of the cell to the outer border; there is a sub-marginal row of roundish dark brown spots, the inner half of which is, in most of them and particularly in the median interspaces, covered by very pale metallic greenish scales; they are surmounted by rather pale orange lunules, edged inwardly with blackish spots, generally assuming the form of rather narrow bent lunules. Outer border narrowly edged with blackish brown, sometimes broadening slightly at the nervure tips. Fringe as in the fore wings.

Abdomen dark brown above, with scattered pale blue or whitish scales and hairs, the former growing more abundant down the sides; beneath whitish. Appendages of male (34: 29) with the alations forming posteriorly extended, tapering, pointed fingers, slightly swollen at the base, running parallel to each other and leaving between them a narrow and exceedingly deep cleft; lateral arms normal, very slight and elongated. Clasps formed on each side of a broad, subequal, scarcely swollen lamina, somewhat more than twice as long as broad, the apical margin angulate and slightly produced, the produced part apparently split and slightly incurved.

Measurements in millimetres. Length of tongue, 6 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	14.25	14.25	15.	13.25	14.	15.
antennae.....	6.65	6.65	7.	6.75	6.75	6.85
hind tibiae and tarsi....	4.4	4.4	4.65	3.75	4.	4.25
fore tibiae and tarsi..	3.	3.	3.15	2.5	3.	3.

Accessory sexual peculiarities. As described above, the sexes differ in coloring on the upper surface of the wings. The same surface bears scattered androconia in the male (46: 29), which are of very regularly obovate form, but with the middle of the

sides parallel, similarly rounded at the two ends, with about ten to twelve parallel rows of connected, moderately large, bead-like dots, which do not extend upon the narrowing base; pedicel slender and equal and not very long; lamina nearly .006 mm. in breadth.

Egg (65:12-13). Of a pale green color, the tracery of raised net work being frost-white upon it. On the sides neighboring triangular or wedge-shaped cells, which average about .04 mm. in length, are often arranged around a common centre so as to give it the effect of being stamped with a number of wheels, of which the irregular centre is sometimes enlarged so much as to be .02 mm. in average diameter; the average cell walls are here about .01 mm. thick. Above, the cell walls are of the same thickness, but the average diameter of the cells is only about .025 mm. The average micropyle cells are about .009 mm. in diameter with the thinnest possible walls; the central cells are only .0075 mm. in diameter. The egg itself is .7 mm. in diameter and half that height.

Caterpillar. *First stage* (71:4). Head (79:32) greenish luteous; ocelli and sutures black; mouth parts pale green. Body pale green; papillae very dark green ringed with black. Legs and prolegs of the color of the body. Hairs hoary, the longer curving ones longer than the width of the body. Spiracles white encircled with black. Length of body, 1.25 mm.; of longest laterodorsal hairs, .4 mm.; of shortest in same series, .15 mm.

Third stage (75:36). Head (79:33) dark olive fuliginous. Body pea-green with a narrow, dorsal, darker green line, margined by a pale stripe following the edge of the narrow, dorsal field and ending with the seventh abdominal segment. Hairs brown. Papillae and annuli blackish, giving a grisly appearance to the body. Spiracles blackish. Length, 4 mm.

Fourth stage (79:34). Differs from the preceding only in that a faint, infrastigmatal, pale line follows the substigmatal fold; and on the sloping sides numerous slender, faint, oblique, paler lines run from above downward and backward at an angle of 45° with the lower margin, each line covering three segments and interrupted at the incisures, the middle segments having parts of four distinct stripes on them. Length, 7 mm.

Last stage (75:38). Head (79:35) piceous; mouth parts fusco-luteous. Body pale pea-green, a little hoary from the delicate pale brown pile, arising from rather sparsely and irregularly scattered, dot-like papillae, black and white in about equal proportion. Dorsal field darker green, especially on the anterior half of the segments, through the readily seen pulsations of the dorsal vessel; the subdorsal ridges pale yellowish and the substigmatal fold white or livid and continuous, a little fainter on the thoracic segment and dying out just before the hinder edge of the last; declivent sides with very faint, pale, oblique stripes as in preceding stage. Spiracles pale with a faint, fine, fuscous annulus; first thoracic segment slightly dulled in color with a central, transverse, roundish, plumbeous-green, rhomboidal shield. Legs pale testaceous with testaceous claws. Prolegs green. Length, 12.25 mm.; breadth, 3.25 mm.; height, 2.5 mm.

Chrysalis (84:41). Pea-green, the head barely paler, the abdomen tinged with yellow excepting along the dorsal line, which is grass-green except posteriorly. The integument is exceptionally translucent, permitting the fatty bodies, the tracheae and the veins of both upper and under wings to be readily seen. No markings whatever. Surface of body covered with a delicate tracery, forming a broken, irregular reticulation of raised lines, next and between which the surface is very delicately wrinkled, everywhere encircling the papillae which never touch them. Spiracles pallid. The sparsely scattered, short, fine, hyaline hairs (86:15, 16) arising from fulvous papillae giving a slight tint to the prothorax where they are most abundant, and where the hairs are of two sorts, a longer, straight and slender, terminating in a bunch of bristles (86:16), the whole length of which, exclusive of the papilla, is .1 mm. and found only on the sides of the prothorax; and a shorter, rather stouter and simple, sometimes slightly curved hair (86:15), .06 mm. long; the latter only are found on other parts of the body. Hooklets of cremaster reddish. The girth passes between the first

and second abdominal segments. Length, 9.5 mm.; breadth at thorax, 3 mm.; at abdomen, 3.6 mm.

Distribution (24: 8). This butterfly belongs to the Canadian fauna, although it has not been detected in all the places we should have anticipated and is very abundant in certain spots beyond these boundaries. For instance, it is not reported from Quebec, Montreal, Ottawa nor the White Mountains, while Mr. Lintner has observed large flocks in a single spot in the vicinity of Albany, New York—the nearest point to New England at which it has yet been discovered. Mr. Edwards even writes that he has seen several specimens in the collection of Mr. Akhurst of Brooklyn, N. Y., which were said to have been taken in that vicinity, while, on the other hand, Mr. Couper found it “common” on the northern shore of the Gulf of St. Lawrence opposite the Mingan Islands, a point closely approaching the Hudsonian fauna. Möschler reports it from the same region, 55° 35' W. Strecker quotes it from Anticosti, Thaxter brought it from Cape Breton, and it is pretty certainly this species which Edwards describes under the name of aster, taken in Newfoundland by Mead. In the west it has been taken as far south as London abundant (Saunders) and Toronto, Ont. (Fletcher), Michigan (Edwards), northern Illinois (Worthington) and Wisconsin “not rare” (Hoy); but it belongs more properly farther north, for it has been taken at Charleton Island, Hudson Bay (Macoun t. Fletcher), at the mouth of the Saskatchewan (Scudder), Lake Labache (Edwards) and Fort Simpson on the McKenzie (Edwards).

It has never been taken in New England, but I do not see why it should not be found on some of the sandy plains of the Connecticut River where *Lupinus* abounds.

Oviposition. By confining the butterfly over *Lupinus* many eggs were laid, generally on the under side of the leaves or on the stalks, sometimes on the upper. They hatch in June in from seven to eight days.

Food plant. The caterpillar has been taken in the field only by Mr. Saunders, who found it upon *Lupinus perennis* Linn. one of the Leguminosae. The European species to which it is closely allied are reported to feed upon *Melilotus*, *Genista*, *Hedysarum*, *Trifolium*, *Onobrychis* and *Colutea*. Our species feeds with the utmost freedom on *Lupinus*, which grows in abundance in the locality near Albany where Lintner finds it, but it must find other food in the high north. Edwards states that it also feeds on *Ceanothus*, one of the *Rhamnaceae*.

Habits of the caterpillar. In the spring of 1887 Mr. Lintner kindly guided me to his happy hunting grounds at Centre near Albany, when for the first time I had the pleasure of making the personal acquaintance of this butterfly, of obtaining eggs and rearing the insect through all its stages. The caterpillar eats its way out of the shell by biting a hole at

one side of the summit, often making a reniform opening out of which it crawls as soon as possible, and leaves the rest of the egg intact.

The caterpillar has a very extensible head and flexible neck and its manner of feeding immediately after birth is rather remarkable; it pierces the lower cuticle of the leaf, making a hole just large enough to introduce its minute head, and then devours all the interior of the leaf as far as it can reach—many times the diameter of the hole—so that when the caterpillar goes elsewhere, the leaf looks as if marked with a circular blister, having a central nucleus; the nearly colorless membranes of the leaf being all that is left, and at the central entrance to the blister the upper membrane only. The blister or pustule is 1.75 mm. in diameter, and the nucleus like opening to it only about .25 mm. in diameter.

In later life, generally by the fourth stage, it feeds as well on the upper as on the under surface of the leaf, though it still seems to prefer the under surface, and in either case eats entirely through the cuticle of the surface on which it rests down to the opposite integument, but never piercing the leaf; it still also retains to some degree its early habit, of piercing by means of its long neck *between* the integuments to get the juicier parts; and I have seen it bore out the cut end of a stem down to the rind on every side. Occasionally, when full grown, it eats the leaf entirely through. It shows no propensity whatever to cannibalism, even under provocation.

Mr. Saunders observed this caterpillar accompanied by ants; indeed he found their discovery "comparatively easy from the invariable presence of these active attendants." The ants were actively running about the leaves on which these caterpillars were found and repeatedly over the caterpillars themselves, which did not seem in the least disturbed by them. Their attendance was of course to obtain the fluids secreted from the seventh abdominal segment of the caterpillar, as in *Cyaniris*.

Life history. This butterfly is double brooded throughout the whole of its range, the first generation making its advent during the last week in May, the females emerging the first week in June when the males are common; the height of its abundance is about the 10th of June, and by the middle of the month the numbers begin to diminish, although specimens may be found even in July, so as to join the second brood when that is early; the eggs are laid throughout June, hatch, as stated, in seven to eight days, the caterpillar becomes fully grown in about a month, and the chrysalis hangs from nine to eleven days. The second brood varies considerably in the time of its apparition. Mr. Saunders reports that the first butterflies appeared one year in London, August 2; while Mr. Lintner took the first at Albany on July 15, another year found them beginning to fly by the 7th, and one year even found them "very abundant" on the 9th. So, too, in the year in which they appeared July 15, a few of both sexes were

found as late as August 27, while in that year in which they emerged early in July, their numbers were diminishing by the 21st, and at the end of the month all the specimens were "quite worn." They appear, therefore, to fly for from four to six weeks. The eggs are doubtless generally laid in both July and August, but whether the mature larva or the chrysalis hibernates is unknown.

Habits and flight. The butterfly collects in large numbers on damp ground. Mr. Lintner once observed nearly two hundred in one spot, and caught fifteen in a single sweep of the net; it may also be found on leaves and flowers by the roadside with its wings partly expanded.

Its flight is entirely similar to that of *Cyaniris pseudargiolus* but somewhat less vigorous; like that species it keeps close to the ground. When walking up a vertical surface the wings are kept back to back, erect, the antennae on a plane with the body, but raised above it by the basal curve, and divaricate about 90° ; they are alternately raised and lowered a little. When hanging at rest, the costal edges of the four wings are brought almost together, while the antennae, spread at an angle of about 60° , are held forward from the vertical of the body at a slight angle.

I cannot discover any odor in the males.

Desiderata. The history of this butterfly needs to be closely followed after August to determine in what condition the insect passes the winter. If in the egg state, as one of its European congeners is said to do, where is the egg then laid? Our knowledge of the geographical distribution of the insect leaves much to be desired; it may be sought in the whole of northern New England with considerable chance of success; no parasites have yet been obtained from the larva. Do the ants defend it so well that it has none?

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- | | | | |
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| <i>General.</i> | | <i>Chrysalis.</i> | |
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| <i>Egg.</i> | | 86: 15, 16. | Dermal appendages. |
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| 86: 14. | Caruncle, 8th abdominal segment. | | |

TRIBE CHRYSOPHANIDI.

COPPERS.

Papiliones rutili Wiener Verzeichniss.
Clives (pars) Herbst.
Villicantes Hübner.

Lycaeninae (pars) Butler: *Lycaenidae* (pars)
 Guénée.

Children of light, and air, and fire, they seem'd;
 Their lives all ecstasy and quick cross motion.
 MONTGOMERY.—*Pelican Island*.

The fairy king of flowers
 Reigns there, and reveals thro' the fragrant hours;
 Gem full of life, and joy.

SAMUEL ROGERS.—*The Voyage of Columbus*.

Imago. Colors coppery. Club of antennae equal for most of its extent, rather long and very slender, being two or three times as broad as the stalk, and from four to six times longer than broad. Patagia very long and slender, usually three or four times longer than broad; subcostal nervure of fore wings with three superior branches, the outermost forked, the nervure itself running in a direct or nearly direct course to just below the tip of the wing; tarsi armed beneath with frequent spines, usually clustered upon the sides; fore tarsi of the male armed at tip with a single median spine, differing from the other spines only in size, and considerably curved. Upper organ of male appendages formed of a deeply cleft plate, whose lateral halves have the appearance of a tapering appendage, and bear at their extreme base slender, elbowed laminae directed backward; clasp subequal and at tip bluntly rounded; intromittent organ acicular, not apically flaring.

Egg. Tiarate, but domed, truncate beneath but not above, the sunken portion of the upper surface, together with the micropyllic pit, including less than one-eighth of the diameter of the egg; the pit itself generally, but not always, moderately deep; surface either simply and finely reticulate, with a scarcely raised tracery, or pitted with polygonal cells, the angles of which do not rise conspicuously above the general surface.

Caterpillar at birth. Head as broad as the body. Innermost dorsal bristles arranged partly in a subdorsal series, one long and one short bristle to a segment in each row; infrastigmatal series with three bristles to a segment.

Mature caterpillar. Body scarcely narrower in proportion to its length than in *Lycaenidi*, but slightly broader than in *Theclidi*; segments arched somewhat; body clothed uniformly with very short hairs, or with longer hairs arranged in transverse series, sometimes springing from elevated bosses.

Chrysalis. Body very variable in form (to include *Feniseca*), but either not forming a single, uniformly contoured mass (*Feniseca*) or else a single, long, oval mass, slenderer and relatively lower than in the *Theclidi*, and generally more elongated than in the *Lycaenidi*; dermal appendages fungiform.

This group contains the stoutest of the *Lycaeninae*, and is far less numerous in species than the tribes already mentioned. Their heavy markings and the lustrous reddish or fulvous tint of their upper surface, which has won for them the popular name of "coppers," distinguish them at a glance from other groups. Their hind wings rarely bear the thread-like tails peculiar to many of the *Lycaeninae*, although in some exotic genera the anal angle is sometimes considerably produced. The disposition of the markings of the under surface closely resembles that in the *Lycaenidi*, to which they

are much more nearly allied than to the Theclidi. Many of the species frequent moist, boggy places, while others rejoice in the full blaze of the sun in arid pastures or by the roadside. Their flight is quick, usually short, abrupt and rather infrequent; they seldom wander far; like some of their allies they are often very pugnacious, darting from their resting place at any passing object.

The insects of this group are peculiar to the temperate regions. South of the tropics a single species occurs in South America, two or three are found in New Zealand, and large numbers in Africa, though probably not appertaining to genera represented in northern latitudes. The mass of the species, however, are found in the northern hemisphere, and especially in the Old World. With one exception, the American genera are either identical with or very closely allied to those of Europe, and this resemblance is most marked when the species of the western half of the continent are compared with those of the Old World.

The eggs are more or less echinoid shaped, generally covered with deep and regular depressions. They are laid singly, though often a large number may be found upon the same plant. The larvae are shaped like an oblong, strongly convex shield, and like the Lycaenidi they feed upon herbaceous plants, rarely, however, on Leguminosae, most of them preferring species of Rumex or other Polygonaceae, and they have been known to occur on Solidago and Viola; in one instance, as we shall see, they are strictly carnivorous. The insects vary considerably in the number of their generations, some being single, others double, and a few even triple brooded; some pass the winter in the egg state, others in the chrysalis, and one or two, it is thought, may winter as caterpillars; the butterflies never hibernate. They differ from other Lycaeninae in their late apparition, being seldom seen on the wing before June, but they resemble them in that few of the species fly after August.

Table of genera of Chrysophanidi, based on the egg.

Egg studded with conspicuous sunken cells.

Egg regularly tetrarate in form; cells small.

Cells formed in the interspaces of conical protuberances.....**Chrysophanus.**

Cells composed of deep circular pits.....**Epidemia.**

Egg broadly and abruptly truncate at base; cells large.....**Heodes.**

Egg nearly smooth, the cells inconspicuous in size and depth.....**Fenisea.**

Table of genera, based on the caterpillar at birth.

Longer bristles at least half the length of the caterpillar; no large bristles aligned with the lateral annuli.

Longer bristles gently arcuate, in the arc of a circle whose radius is twice the width of the caterpillar.....**Chrysophanus, Epidemia.**

Longer bristles strongly arcuate, in the arc of a circle whose radius is the width of the caterpillar.....**Heodes.**

Longer bristles considerably less than half the length of the caterpillar; a lateral series of large bristles aligned with the annuli.....**Fenisea.**

Table of genera, based on the mature caterpillar.

- Body furnished with short hairs uniformly distributed.....**Heodes**.
 Body furnished with long hairs, arranged in transverse masses.....**Fenisea**.
 (Other genera unknown.)

Table of genera, based on the chrysalis.

- Abdomen smoothly contoured, last segments not separately protuberant.
 Only the lower half of the dorsum of ninth abdominal segment sloping forward.....**Chrysophanus**.
 Whole of the dorsum of the ninth abdominal segment sloping forward.....**Heodes**.
 Abdomen with irregular surface, the final segments forming a broad spatula.....**Fenisea**.
 (Epidemia unknown.)

Table of genera, based on the imago.

- Third superior subcostal nervure of fore wing arising at the tip of the cell.
 First joint of middle and hind tarsi in male not greatly enlarged; disk of upper surface of fore and hind wings not heterochroic, or only in the female.
 Fore and hind wings heterochroic above in the female; club of antenna comparatively slender; fore tarsi of male jointed.....**Chrysophanus**.
 Fore and hind wings homochroic above in both sexes; club of antenna comparatively stout; fore tarsi of male not jointed.....**Epidemia**.
 First joint of middle and hind tarsi in male twice as stout as rest of tarsus; disk of upper surface of fore and hind wings heterochroic in both sexes.....**Heodes**.
 Third superior subcostal nervure of fore wing arising far beyond the tip of the cell.....**Fenisea**.

CHRY SOPHANUS HÜBNER.

Chrysophanus Hübn., Verz. bek. schmett., 72 (1816). *Type*.—*Pap. hippothoe* Linn.

As rising on its purple wing
 The insect-queen of eastern spring,
 O'er emerald meadows of Kashmir
 Invites the young pursuer near,
 And leads him on from flower to flower
 A weary chase and wasted hour,
 Then leaves him, as it soars on high,
 With panting heart and tearful eye;
 So beauty lures the full-grown child,
 With hue as bright, and wing as wild;
 A chase of idle hopes and fears,
 Begun in folly, closed in tears.

BYRON.—*The Giaour*.

Imago (55:8). Head moderately large, densely clothed with scales and rather abundantly supplied with long, curving hairs of equal length in all parts. Front even, not swollen in any part, except in the least possible degree in the middle below, where it barely surpasses the front of the eyes; half as high again as broad and of the width of the eye on a front view; upper border marked by the faintest possible transverse ridge, its angles rather deeply hollowed in front of the antennae; lower border rather strongly, not broadly rounded. Vertex slightly elevated in the middle and at either side to form low buttresses behind the antennae; separated from the occiput by a broad, rather deep, slightly curving sulcation, having a slight pit in the middle, which affects the height of the occiput just behind. Eyes not very large, moderately full, naked. Antennae inserted with the posterior border in the middle of the summit, separated by a space equal to the width of the basal joint of the antennae; nearly or quite half as long again as the abdomen, composed of thirty-three joints, of which thirteen form the depressed cylindrical club, which is two and

a half times broader than the stalk, five times longer than broad, increases very gradually in size at the base, is equal for most of its length and bluntly pointed at the extremity, three or four joints entering into the diminution of size. Palpi slender, fully half as long again as the eye, the middle joint tapering only on the apical third, the terminal joint more than half as long as the penultimate and clothed with recumbent scales only, while the others are densely scaled, especially below, and furnished with a heavy fringe of very long, projecting hairs.

Patagia very long and slender, somewhat arched and slightly tumid, nearly or quite four times as long as broad, tapering on the basal half, the apical half about one-third the width of the base, equal or very slightly enlarging, nearly straight, the tip broadly rounded; upper border not excavated.

Fore wings (39:23) two-thirds as long again as broad, the costal margin slightly and equally curved at base and tip, the middle two-thirds nearly straight; outer margin very broadly and uniformly rounded, having such a general direction as to form an angle of about 65° with the costal margin, the angle rounded off; inner border scarcely concave on the basal two-thirds, the angle well rounded. Costal vein terminating some distance before the tip of the cell, subcostal with three branches, first arising a little (♂, 61:7) or somewhat (♀, 61:8) beyond the middle of the upper border of the cell; second about two-thirds (♂) or nearly three-fifths (♀) the distance from the origin of the first branch to the tip of the cell; third at the apex of the cell, its forks originating midway (♂) or a little less than midway (♀) from the tip of the cell to the apex of the wing; cross veins transverse, obsolete except next the main veins: cell rather less than half the length of the wing and three and a half times as long as broad.

Hind wings with the costal margin broadly and roundly expanded next the base, beyond nearly straight, near the apex sloping off toward the outer margin, sooner and more abruptly in the ♂ than in the ♀. Outer margin rather broadly and regularly rounded, fuller, especially on the upper half, in the ♀ than in the ♂; inner border abruptly and considerably expanded at the base, beyond straight or scarcely convex, scarcely emarginate for a short space next the tip, the angle rounded off. Submedian nerve terminating at the anal angle; internal nervure terminating considerably beyond the middle of the inner margin.

Fore tibiae less than three-fourths (♂) or about five-sixths (♀) the length of the hind tibiae, the spurs naked; the tarsi either nearly equalling the tibiae (♀) or from three-quarters to four-fifths their length (♂); terminal joint of fore tarsi either like that of the other legs (♀); or small and tapering, feebly divided by faint impressed lines into simulations of joints, the tip armed with only a single apical hook, differing from the spines which crowd up to it only in being longer and a little more curved; furnished above with short, dense hairs, instead of scales (♂). All the femora provided with a fringe of rather close, long hairs on the under surface. Middle tibiae either as long as (♀) or a little shorter than (♂) the hind tibiae, rather abundantly armed beneath, and to a slight extent on the sides, with not very long but slender spines and at the apex with a pair of moderately short and slender spurs scaled nearly to the tip. First joint of tarsi fully equalling the others together, the next three diminishing in regular ratio, the fifth equal to the second; the joints furnished very abundantly beneath with very long and rather slender spines, excepting on the basal joint mostly collected upon the sides and in a naked field; an apical pair on each joint longer than the others; claws small, not stout, compressed, tapering, considerably and regularly but not very strongly curved; paronychial double, each lobe fully as long as the claw, equal, very slender, the superior straight, the inferior curving strongly inward and forward; pulvillus inconspicuous.

Lateral alations of upper organ of male abdominal appendages pretty large, bent strongly downward in the middle, divergent, leaving a U-shaped opening between their bases; lateral arms very long and slender, acicular, strongly bowed. Clasps very uniform in size from base to tip.

Egg. Slightly more rounded above than below, the base being rather broadly truncate; cells small, those in the middle of the egg disposed with some regularity in

diagonal rows, the walls of irregular height, being much elevated into rounded bosses at the lines of juncture. Micropyle rosette occupying the whole floor of a pretty deep infundibuliform cavity, the sides of which are abrupt.

Caterpillar at birth. The only specimens I have seen being dead and dried bodies extracted from eggs which did not hatch, I can only say that the caterpillars of this genus when they first emerge resemble those of *Heodes* in almost every particular, but that the secondary warts of the infrastigmatal row are apparently absent.

Chrysalis. Considerably more than twice as long as broad, the sides of the body straight and parallel from one extremity of the wing to the other; behind the wings the abdomen as viewed from above is elliptical, well rounded; in front of the wings the body tapers rapidly and has an appressed rounded front, the basal wing prominences being marked only by the angle the front part of the body makes with the wings. Viewed from the side, the flat bottom has the anterior fourth raised at a slight angle; the thorax is highest and nearly equal on the posterior third, in front of it very broadly arched, sloping about equally downward and forward. Abdomen very broadly arched above, highest and very slightly higher than the thorax at the third and fourth segments, the last four segments curving rapidly downward, the posterior point being at the summit of the ninth segment, below which it curves forward slightly; the downward curve at the posterior is much more rapid than at the anterior end of the body. Transversely the middle of the thorax has a parabolic curve, well rounded above; the abdomen is well arched, regularly rounded, considerably higher than a semicircle. More than three-fifths of the tongue is exposed. Basal wing prominence consisting of a broad, low, rounded, slight elevation which would be scarcely noticeable but for the narrowing of the anterior part of the body. Body covered equally with a very delicate tracery of lines, equally raised everywhere excepting at the points of intersection where there are minute warts; they cross each other irregularly, forming angular, moderately large cells; within the cells is frequently seated a large wart giving rise to a fungiform bristle, the basal three-fourths of the pedicel equal, moderately stout, the apical fourth rapidly expanding to a shallow, greatly expanded, infundibuliform disc, the horizontal edges of which are fringed with fleshy ciliate lobes. Hooklets of cremaster rather long and slender, the stem equal, straight on basal, curved a little on apical half, the expanded portion transverse, three or four times broader than the stem, curved strongly, over the apical margin nearly straight, the sides strongly produced laterally and somewhat backward.

This genus seems to have but a single form in America, confined to the eastern side of the continent, though better represented in Europe where its range is also more extended between the 37th and 56th parallels.

The group comprises some of the larger *Chrysophanidi*. The wings of the sexes differ in coloring, though, at least in the American species, but little in form. The upper surface is coppery brown, that of the fore wings mostly fulvous in the female, broadly bordered with dark brown on the fore, reddish fulvous on the hind wings; and is furnished with transverse series of dark spots, the repetition of those beneath and which are more distinct on the fore wings of the female than of the male. Beneath, the fore wings are fulvous, the hind wings silvery gray, bordered as above; both wings have a double, submarginal series of blackish spots and an extra-mesial tortuous series; all the spots on the wings are small and generally round; besides there is a dark bar at the end of the cell, and at equal distances between this and the base two straight and transverse series of spots.

The insects are double brooded and probably winter in the egg state.

The American species flies in July and at the end of August. The butterflies are rather local and their flight low and not very active. The eggs are white, echinoid shaped, strongly pitted and with prominent, rounded elevations. The caterpillars, which are imperfectly known, feed upon Polygonaceae and especially Rumex. The chrysalis has much the form of that of *Heodes* and of a similar dull brown.

**EXCURSUS XXXVI.—THE DISTRIBUTION OF BUTTERFLIES
IN NEW ENGLAND.**

The woods, the rivers, and the meadows green,
With his air-cutting wings he measured wide,
Ne did he leave the mountains bare unscene,
Nor the rank grassie fennes delights untride.

SPENSER.—*Muirpotmos*.

PROBABLY no district of equal extent in the United States possesses a greater variety of butterfly life than New England. Extending in a north-easterly direction over more than eleven degrees of latitude and seven and one-half degrees of longitude, its broad north-westerly side supporting a range of hills which forms the backbone of the district, higher than any equivalent range east of the Rocky Mountains, it exposes a vast coastal plain to the open sea, one-half of which receives the warm waters of the Gulf Stream, the other the colder Arctic flow which hugs the shore as far as Cape Cod. Its north-easterly extremity stretches far toward the Gulf of St. Lawrence, with its sub-arctic cold, and nourishes only the butterflies of the Canadian fauna, while its low, sandy southern shore receives many a wanderer from the Carolinian fauna, which struggles to maintain a foothold and even to penetrate along the coast and up the warmer river valleys. On the summits of the highest mountains we are even brought, as it were, into the very heart of Labrador and Greenland, and from there, one may say with but little exaggeration, we may look upon the tropics.

The main distinction, then, which we find among the butterflies of different parts of New England is that we find within its limits a commingling of northern and southern faunas. Indeed, as we have pointed out in the Introduction to this work, the line between the Alleghanian and Canadian faunas divides it near the middle in an irregular course, influenced largely by the flow of the streams and the trend of the mountain chains. The different species which find their northern and southern limits within these districts have been detailed in the chapter of the Introduction bearing upon this point, and there are only one or two additional matters which may claim our attention here.

The distribution of butterflies, as is well known, depends very largely upon that of their food plants, and the latter in most regions upon the

character of the soil. In New England, however, buried as it is from one extremity to the other beneath a vast sheet of drift, this element has the very weakest proportions. The distribution of limestone areas has in most countries very close connection with the distribution of plants, and were it not for this covering of drift, which envelops the whole of New England, we might look here for some considerable difference between the eastern and western portions, since the limestones of New England are very largely confined to the Connecticut valley and the region west of it. Their effect, however, upon the actual character of the soil is, compared to that which we find in other regions, and considering their extent, exceedingly small, and, perhaps consequently, we have scarcely any butterflies whose limitations in an east or west direction can in any way be claimed to be dependent upon any other element than that of a northerly or southerly exposure. *Polygonia satyrus*, indeed, has been found only at a single point just outside the north-western extremity of New England, and here finds its easterly limit. It is a butterfly which belongs, properly speaking, to the other side of the continent, but, like others in the same category, doubtless extends across nearly the entire continent north of our own boundaries. But such examples as this should be looked upon rather as northerly forms which, belonging to the western and central portions, but traversing the continent in northern latitudes, naturally invade our territory from the west. The same should be said of *Rusticus scudderii*, the relations of which to New England are those of a northerly and westerly neighbor. *Eurymuseurytheme* is a further example.

The only instances known to me where butterflies, entering New England from the west or west and south, do not cross the district at least nearly to its eastern boundaries are: *Chrysophanus thoe*, which has never been found farther east than Amherst in the Connecticut River bottom, *Thecla acadica*, whose New England distribution is exceedingly little known; and *Strymon titus*, which appears only to reach the extreme western border of Maine. Of these three, *Chrysophanus thoe* is the only striking example, and its limitation may possibly be only apparent, and due to its localization.

We see, therefore, that the geographical distribution of butterflies in New England is almost completely an element of the temperature. The mountains and the streams run in a general north-southerly direction, not only offering no obstacles to the freedom of movement north and south, but affording not infrequently a highway, facilitating movement. The relation of the coastal line to the currents are such that the extremes of the north and south are intensified. In this narrow area, therefore, are crowded not only abundant representatives of the Canadian and Alleghanian faunas, but even some vagrant or ambitious members of the Hudsonian, upon the mountain tops, and of the Carolinian, along the low southern coast.

CHRYSOPHANUS THOE.—The bronze copper.

[The bronze copper (Seudder); the large copper butterfly (Maynard).]

Polymnathus thoe Bois. MS.; Gray, Griff. Cuv. an. kingd., Ins., II, pl. 58, figs. 4, 4 a-b (1832);—Bois. LeC., Léop. Am. sept. 125-126, pl. 38, figs. 1-3 (1833);—Guér., Icon. règne anim., Ins., 490, pl. 81, figs. 4, 4 a (1842?);—Morr., Syn. Lep. N. Am., 84-85 (1862);—Saund., Can. ent., I: 57 (1869);—Gir., Traité d'ent., III: 237, pl. 84, figs. 4, 4a-b (1865).

Chrysophanus thoe Westw.-Hewits., Gen. diurn. Lep., II: 498 (1852);—D'Urb., Can. nat., v: 246 (1860);—French, Rep. Ill. Ins., VII: 168

(1878); Butt. enst. U. S., 281-282 (1886);—Middl., Rep. Ill. Ins., x: 65 (1881);—Seudd., Butt., 128-129, figs. 12, 117, 124 (1881);—Mayn., Butt. N. Engl., 40-41, pl. 6, figs. 61, 61a (1886).
Lycaena thoe Kirby., Syn. cat. Lep., 343 (1871).

Chrysophanus hyllus Butl., Cat. Fabr. Lep., 173 (1860).

Figured by Glover, Ill. N. A. Lep., pl. 25, fig. 9, ined.

[Not *Papilio hyllus* Cram.]

Thy sun-ray is bright
On the butterfly's wing.

ELIZA COOK.—*Spring*.

Those be rubies, fairy favours.

SHAKESPEARE.—*Midsummer-Night's Dream*.

Imago (5: 9, 12). Head covered with velvety black hairs and scales; a moderately narrow band of snow white scales and a few hairs runs around the eye, from the front of the antennae nearly to the back of the same, broadening on the lower half of the eye behind and connected together by a rather broad, white band above the base of the tongue; a line of white hairs starts at the inner edge of these bands where they commence in front of the antennae, and passing on the inside of the latter run straight backward to the top of the head, where they curve toward each other and connect. Palpi with the basal and the greater part of the penultimate joint silvery white; the upper surface of the apical half of the latter, together with the apical third or fourth on both sides, abruptly changing to black, the white fringe on the under surface often with a few black hairs near the apex; terminal joint black, excepting the under surface and the extreme tip which are white; occasionally the base is narrowly annulated with white on the outside. Basal joint of antennae clothed externally with white; stalk black, annulated at the base of each joint with white, most broadly upon the lower portion of the outside, where, on the basal five or six joints, the white scales form a continuous line; club black, the basal joints narrowly annulated at their base with white, the apical two or three joints orange, and sometimes a portion of the under surface enlivened with an infuscated tinge of the same.

Thorax covered above with brownish fulvous hairs, brightest on the prothorax and patagia; beneath pearly white, the legs the same, the basal half or more of the smaller tarsal joints black above; the same joints fuscous beneath, laterally edged with black; spines black; spurs white, tipped with light castaneous, the point darker; claws reddish luteous; pulvillus blackish fuscous, sometimes pale at the edge.

Wings above: *Fore wings*; second superior subcostal nervule originating at two-thirds the distance from the base of the first nervule to the apex of the cell in the male; third superior nervule arising midway (♂) or less than midway (♀) from the tip of the cell to the apex of the wing. Colors either yellowish brown tinged slightly with rusty red and having a faint violaceous reflection (♂); or, rather pale orange fulvous (♀), the extreme base infuscated, the costal edge orange, the costal border narrowly (♂) or broadly (♀) bordered with blackish fuscous; the outer border similarly bordered, either vaguely and narrowly to the distance of less than half an interspace (♂), or, distinctly and broadly to the width of an interspace and a half (♀); the female has also the inner border margined with fuscous to just beyond the

submedian nervure and scattered fuscous scales in the basal half of the cell and the bases of the median and medio-submedian interspaces; the termination of the cell is marked by a narrow (♂) or broad and distinct (♀) transverse black stripe; a transverse blackish spot in the middle of the outer two-thirds of the cell, not reaching either nervule, and a similar one below it, just beneath the first divarication of the median nervure, one sometimes as distinct (though never so large) in the male as in the female, but besides there are a number of spots, either rather large and very distinct (♀) or much smaller and very faint—as if they were only spots of the under surface appearing above by the partial transparency of the wings (♂); such are a small spot in the middle of the basal two-thirds of the cell and a transverse series of seven black spots in the middle of the outer half of the wing, often followed, in the female, by a sprinkling of blackish scales to a considerable distance on the inner side; the upper four, in the interspaces above the median nervure, are arranged in a nearly straight line, the third a very little outside of it, placed at an angle of about 140° with the costal border, the fourth spot in the centre of the subcosto-median interspace; the sixth spot is in the middle of the lower median interspace and a little outside of the fifth in the interspace above; the lowest is double, seldom obsolete, below and a little within the sixth; outer border narrowly edged with black, imparting its depth of color to the base of the fringe, which beyond is pale fuscous, mixed with blackish. Outer margin of the *hind wings* slightly and roundly emarginate in the medio-submedian interspace, especially in the female. Color of hind wings slightly grayish black brown, a little paler in the male than in the female and possessed also of a very slight olivaceous reflection, the base of the median area with numerous long, pale brownish fulvous hairs; the extremity of the cell marked by a narrow, blackish streak, often broken in the middle; in the middle of the outer and of the inner two-thirds of the cell a rather small, round, obscure, sometimes obsolete, blackish fuscous spot; a similar one in the upper portion of the costo-subcostal interspace, just within the first divarication of the subcostal nervure, and another in the middle of the medio-submedian interspace, a little beyond the base of the lowest median nervule; a transverse series of eight similar roundish spots, often very obscure, crossing the middle of the outer half of the wing; the upper three, in the lower subcostal interspaces, are in a straight row, the uppermost as far from the inner spot of the costo-subcostal interspace as it is from the base of the interspace; the third in the centre of the lower subcostal interspace; the fourth in that of the subcosto-median interspace; the sixth nearly on a line with the third and fourth, while the fifth is removed inward from that line by its own width, the seventh and eighth side by side in the medio-submedian interspace and, with the sixth, parallel to the outer border; at the tip of the submedio-internal interspace is an oblique streak, seldom seen, within the row of spots; the outer border is conspicuously marked by a broad, orange margin, slightly broader in the female than in the male, extending from the inner border, narrowing slightly (at least in the male) to the middle subcostal nervule and sometimes, to a slight degree, upon the interspace above; it does not quite reach the border, being separated by a narrow black margin, upon which are seated, in the interspaces and at the outer limit of the orange belt, rather small, round, black spots; two or three obscure, black spots are sometimes seen seated upon the interior border of the orange belt in the subcostal and subcosto-median interspaces; basal half of fringe black; beyond white, interrupted narrowly at the nervure tips with black or blackish fuscous, most distinctly on the lower half of the wing.

Beneath: *Fore wings* pale (♀) or very pale (♂) orange, the black markings of the basal three-quarters of the upper surface repeated, but slightly smaller; there is a submarginal series of subsemilunar spots, the straight side outermost, at a distance of an interspace from the outer border; beyond this, the outer border, at least in the upper two-thirds of the wing, is silvery gray, enclosing, in the interspaces, next the margin, but more distinctly below than above, a series of small, irregular, blackish spots; outer margin delicately edged with black, extending upon the base of the fringe,

which beyond it is silvery gray. *Hind wings* silvery gray, the black spots of the basal three-quarters of the upper surface repeated distinctly as roundish black spots, encircled narrowly with white, and, in addition, a similar spot in the costo-subcostal interspace, midway between the base and the spot next beyond it; the orange band next the outer border is repeated beneath, separated narrowly by silvery gray from the black edged border, but the black spots enclosed in its exterior border are much smaller than above; a similar series of black spots borders the interior edge of the band, occurring in the interspaces as far as the lower median nervule, edged interiorly with white; they occur also in the costo-subcostal, the upper subcostal and the submedial interspaces; fringe much as on the upper surface.

Abdomen purplish black above; the lower portion of the sides with frequent brownish fulvous scales; beneath white, tinged with yellowish toward the tip; the male abdominal appendages (34:37) having the lateral alations strongly compressed, slightly twisted outward at the band, their tips very bluntly pointed; tips of the delicate lateral arms acicular, upcurved. Clasps reaching beyond the alations of upper organ, the tip scarcely produced, bent inward and scarcely downward.

Measurements in millimetres. Length of tongue, 5.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	16.5	17.5	18.5	19.	19.25	20.
antennae.....	8.6	8.9	9.2	9.	9.	
hind tibiae and tarsi..	9.4	5.6	5.8	6.	6.	6.
fore tibiae and tarsi..	3.8	5.8	4.1	4.	4.	4.

Described from 8 ♂ 5 ♀.

Accessory sexual peculiarities. Besides the difference between the sexes in the coloring of the upper surface of the wings, described above, this same surface shows in the male some untoothed scales, not found in the female and therefore probably to be regarded as androconia (46:34). They are asymmetrical long oval in shape, about two and a half times longer than broad, slightly broader on distal than on proximal half, rather broadly rounded at tip, the basal lobe of one side very prominent and the striations more or less oblique.

Egg (65:19). Cells on the sides disposed somewhat regularly, so that one may trace rows directed upward and to the left at an angle of sixty-five degrees with each other; the cells are the interspaces between conical protuberances with regular rounded summits, .0763 mm. apart, each connected with the adjacent ones by a thin wall, partitioning the cells, which mounts more than half way up the sides of each elevation; they produce the effect of stellate ridges, in the middle of the sides very regular, six-rayed, but above exceedingly irregular, then more frequent, changing gradually in appearance by the enlargement of the centre and the diminution of the rays, until on the upper surface the egg is white and uniform, pitted with little roundish and oval cavities, about .04 mm. in diameter; the conical elevations, at the greatest, are about .04 mm. and the partition walls about .0127 mm. in diameter. Micropyle pit (68:13) .0763 mm. in diameter, the central cell circular, .003 mm. in diameter, the large cells surrounding it six or seven in number, oval, their longer diameter directed toward the centre and .013 mm. long, their shorter diameter .01 mm.; the secondary cells nearly circular, .0085 mm. in diameter; the whole net work of cells is very slightly raised above the surface and very indistinct. Color pale green. Height, .4 mm.; breadth, .84 mm.

Caterpillar. First stage. Studied after death only. Head fuscous, with black ocellar field. Body apparently dusky yellow, bristles pale. The upper longest bristles are .44 mm. in length and the spicules excessively minute, though larger than in *E. epixanthe*. The shorter superior bristles are .165 mm. long; the lateral bristles are .14 mm. long and only .00425 mm. broad at base, while the spicules are minute, less than half as long as the diameter of the base of the bristles. Length estimated at .9 mm.

Chrysalis (84:50). Light yellowish brown sometimes an aureous tinge, the tongue a little darker, and the inner sides of the legs and the interspaces of the wings rather

heavily marked with brownish fuscous, having a tinge of red. Prothorax with three small, round, brownish fuscous spots on either side, at the angles of a pretty large triangle, the inner ones laterodorsal; an obscure fuscous, dorsal line on the front of the mesothorax and a pair of small, round, obscure fuscous spots on the middle of the same; midway between them and the hinder edge another more distant pair. Abdomen with a lateral, central, a laterostigmatal posterior, a stigmatal posterior, an infrastigmatal posterior, a ventrostigmatal central and double subventral, central series of similar, often obscure spots on all the exposed segments. Warts supporting fungiform bristles black; the bristles wholly colorless. Spiracles luteous, sometimes with an aureous tinge; the raised lines and their warts are of the color of the body. Length, 9.5 mm.; breadth, 4 mm.; height, 4 mm.; length of fungiform bristles above wart, .064 mm.; of equal portion of pedicel, .047 mm.; diameter of basal papilla .015 mm.; of pedicel, .0085 mm.; of disc including lobes, .064 mm.; length of lobes, .0085 mm.

Distribution (25:1). This member of the Alleghanian fauna has a somewhat peculiar distribution. Its southern limits—and it appears to be rarer in the southern than in the northern limits of its distribution—seem to be not far from the 39th degree of latitude, or perhaps the annual isotherm of 53°; for the southernmost localities from which it is recorded are New Jersey (Andrews), Philadelphia “rare” (Blake) and Cincinnati “not common” (Dury). To the north it has been taken at Lake George (Perot), Lachine “very rare” (Caulfield), Province of Quebec “plentiful” (Fyles), Ottawa “in numbers” (Fletcher), Lansing, Mich. (Miles), Racine, Wisc. (Hoy), and even at Nepigon north of Lake Superior (Fletcher), and recently by Mr. Tyrell at Miry Creek and Vermilion River in the north Saskatchewan region (Fletcher), these last localities about doubling its previously known range. Throughout New York (including the Adirondacks), northern Ohio, Indiana and Illinois, as well as southern Ontario and Michigan it is common, and it has been taken westward on this range in Iowa (Parker, Putnam), Minnesota (Scudder) and eastern Kansas “rare” (Snow), and according to Edwards in Nebraska and Colorado. The reference to its occurrence in Newfoundland given by me in the Buffalo Bulletin is, I think, an accidental error. I can find no authority for it.

In New England it has never been taken east of the Connecticut valley, and the reported captures are few. In New Hampshire the White Mountains (Sanborn), Walpole “one specimen” (Smith); in Vermont, Stowe one specimen (Miss Soule); in Massachusetts, Springfield “not uncommon” (Emery, Dimmock), Amherst (Marsh), Mt. Tom (Morrison), Belchertown and north Leverett (Sprague), Lenox “common” (Edwards) and Williamstown rather rare (Scudder); in Connecticut, New Haven “not uncommon” (Verrill, Harger).

Haunts. The butterfly frequents moist meadows, salt marshes, and the springy margins of brooks. In the salt marshes, Professor Verrill found it among the sedges. It seems nowhere to be a very abundant insect, and is only not so local as *Epidemia epixanthe*.

Oviposition. The only eggs that I have seen were some laid on the inside of the lid of a chip box (Saunders); and others laid by a female confined over yellow dock; the latter (about twenty) were nearly all laid on the seed pods, the only exceptions being one on the stem and one on the upper surface of a leaf—all near the summit of the plant.

Food plant of caterpillar. According to Mr. Saunders, the caterpillar has been reared by Mr. Beadle on a species of *Polygonum*. French and Miss Middleton say that it feeds on prickly ash; the latter, however, adds *Polygonum* to the list and French in his latest publication gives neither, but *Rumex crispus* only; this last plant has also been given me by Mr. Edwards as that on which it had been raised.

Life history. The insect is double brooded, hibernating in the egg state. At what date the eggs hatch is unknown, but the first butterflies of the year appear in the third week of June, the earliest date recorded being the 16th; they lay their eggs early in July (mine July 1, Mr. Saunders's July 6) and occasional butterflies are found almost to the end of the month; the second brood appears by the twelfth of August, becomes common before the 20th and flies until the middle of September; the eggs are laid in this month.

Habits, etc. The butterfly may be "taken on low bushes and tall, flowering shrubs, never on clover" (Emery), and is said to be particularly fond of "certain *Solidagos* and Canada thistle" (Edwards).

Desiderata. This insect is so rare that comparatively little is known of its history, which would not be difficult to follow in places where it occurs. Of the earlier stages we know next to nothing of the caterpillar, and the duration of both egg and chrysalis has never been given. Even the exact seasons of the butterfly need better determination and its flight and attitudes should be described. We are not certain about its condition in the winter time, and if, as probable, it is passed in the egg, it would be interesting to know what sort of a spot is selected by the female for the place of deposit, which can hardly be upon a *Polygonum* or a *Rumex*. Further observations on the distribution are needed, especially in the west and north.

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- | | |
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| <i>Egg.</i> | 46:34. Androconium. |
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EPIDEMIA SCUDDER.

Epidemia Scudd., Bull. Buff. soc. nat. sc., iii, Type. — *Polyommatus epicarthe* Boisd.
127 (1876). LeC.

How strange!
Look at the woman here with the new soul,
Like my own Psyche's,—fresh upon her lips
Alit, the visionary butterfly,
Waiting my word to enter and make bright,
Or flutter off and leave all blank as first.

BROWNING.—*Pippa Passes*.

Imago (55:9). Head moderately large, densely scaled, and furnished above rather abundantly with very long, delicate, arching hairs and in front with shorter, stouter ones, shorter below than above. Front with even, scarcely convex surface, nowhere reaching the front of the eyes; half as high again as broad, and of the width of an eye on the front view; upper border straight, its angles rather deeply hollowed by the antennal pits; lower border very strongly and rather broadly rounded. Vertex with even surface, separated from the occiput by a rather broad and shallow sulcation, and behind it the somewhat tumid occiput marked by a mesial longitudinal indentation. Eyes not very large, tolerably full, naked. Antennae inserted with the posterior border distinctly in advance of the posterior border of the eye, separated from each other by a space rather more than equalling the basal joint; about half as long again as the abdomen, composed of thirty-four joints, of which sixteen form the compressed, subarcuate, obfusiform club, which is fully three times as broad as the stalk, less than four times as long as broad, increases gradually in size on the basal half, is broad and bluntly rounded apically, only two joints entering into the rapid apical diminution. Palpi slender, nearly half as long again as the eyes, the middle joint tapering throughout more than the apical half, the apical half the length of the middle joint, and heavily covered with recumbent scales, while the others are heavily fringed beneath with long scales and projecting hairs.

Patagia very long and slender, somewhat arched in both senses, two and a half times the basal width, tapering on the basal two-thirds, the apical half about a fourth the width of the basal, equal, the tip rounded; upper border entire.

Fore wings (39:22) half as long again as broad, the costal margin slightly convex at base and tip, the more strongly at base, the middle portion nearly straight; outer margin broadly rounded, more arcuate in the upper third than below; inner margin straight. Costal vein terminating scarcely before the tip of the cell; subcostal with three branches, the first arising somewhat beyond the middle of the upper border of the cell; the second much nearer the tip of the cell than the base of the first (♂) or midway between them (♀); the third barely before the tip of the cell, forking midway (♂) or a little less than midway (♀) from the base of the nervure to the end of the lower branch; the subcostal nervure itself slightly flexed at the extreme apex of the cell; cross veins closing the cell as in *Chrysophanus*; the cell half the length of the wing and nearly four times as long as broad.

Hind wings differing in form from those of *Chrysophanus* only in being proportionally longer and with the outer margin less broadly rounded. Submedian nervure terminating at the anal angle; internal nervure terminating scarcely beyond the middle of the inner margin.

Fore tibiae five-sixths as long as the hind tibiae in both sexes, the tarsi slightly shorter (♂) or slightly longer (♀) than the tibiae; terminal joints of fore tarsi either like those of the other legs (♀), or forming a single entirely undivided joint, slender and tapering, armed at tip with a single apical hook differing from the spines leading up to it only in being longer and curved (♂). The remainder of the legs agree in all respects with *Chrysophanus*, except that the tarsal joints beyond the first are more nearly equal in length.

Male abdominal appendages pretty closely resembling those of *Chrysophanus*, but the alations of the upper organ are bent nearer the base, appressed and not compressed, the interval between them V-shaped; the lateral arms are relatively smaller, bent less strongly and less regularly tapering. Clasps with a small bullate base, and beyond a very slender, elongate lamina, incurved at tip.

Egg. Much more rounded above than the below, being higher in proportion to breadth than in *Chrysophanus*. Cells small and uniform, the walls of nearly uniform height, a little elevated in rounded bosses at the lines of juncture. Micropyle rosette occupying the floor of a very deeply sunken well with vertical or overhanging walls.

Caterpillar at birth. Only a dead and dried specimen has been seen,—not enough to distinguish it properly from *Chrysophanus*.

This group of smaller *Chrysophanidi* is much better represented in America than in Europe, and on both continents spreads from ocean to ocean; it thus occupies a belt of about 15° of latitude, mostly north of 40° N. Lat. In Europe there are a couple of species, one of which spreads across Asia as well, while in America we have three, one northern, one eastern and one western, besides a couple more western forms belonging to a distinct section of the genus, in which the basal tarsal joint of the males is not at all enlarged. In New England a single species occurs, which extends to the north until it meets the northern species thought by some to be rightfully considered the same.

The butterflies are among the smallest of our coppers. The ground color of the upper surface of the front and hind wings is alike both in the male and in the female (at least in the American forms), though there is more or less difference in tone, sometimes a decided difference, between the males and the females, the former inclining to brown with purple reflections, the latter to dull or brownish fulvous. The difference is least conspicuous in the species here treated. Beneath, the general coloring is much as in *Heodes*, with in the main the same distribution of dark spots that is found in *Chrysophanus* (repeated to a greater or less extent above), only the extra-mesial series on the hind wing is generally reduced nearly to black points or to slender lunules; the markings here, which are usually very light, show a tendency to form an extra-mesial series of unconnected slender lunules, recalling in one of the extreme western species, their appearance in the species of *Tharsalea*. The antennal club is rather shorter than usual, and the fore tibiae of the male longer than usual, more than equalling the length of the fore tarsi.

The insects, so far as known, are single brooded, flying a comparatively brief time in midsummer. They are extremely local, frequent marshy spots, and presumably hibernate in the egg, though their life history is in no way known. Their flight is short and not very vigorous. The eggs are white, echinoid, strongly pitted, with nearly equal cell walls. The caterpillar is said to resemble that of *Heodes* and to feed on *Polygonum*.

EXCURSUS XXXVII.—LOCAL BUTTERFLIES.

There he arriving, round about doth fle,
 From bed to bed, from one to other border;
 And takes survey, with curious busie eye,
 Of every flowre and herbe there set in order;
 Now this, now that, he tasteth tenderly,
 Yet none of them he rudely doth disorder,
 Ne with his feete their sliken leaves deface;
 But pastures on the pleasures of each place.

SPENSER.—*Malopotmos*.

THERE is a great difference between butterflies as regards their roaming habits. Some may be looked for almost anywhere. They course over the country in every direction seeking the sweetest flowers, and, although there may be certain haunts which they appear to prefer, they range the whole region in search of flowers. You may find them by the dusty wayside, in green meadows, along the river banks, in the shaded roadway through the forest. Others again, and they are by far the larger number, have their own special haunts which they rarely quit. There are some which may not be looked for excepting in the depths of the forests, though these are but few in our temperate climate; such, for instance, is *Anthocharis genutia*, some of the satyrids, and most of the species of *Thanaos*. Others are fond of the shrubbery by streams, like many of the Theclidi, though they are not altogether confined to such localities. Many will be sought in vain out of the bright hot sunshine, like our common *Heodes hypophlaeas*; while others again are limited to swampy areas, like many of the *Melitaeidi* and *Epidemia epixanthe*. In most at least of these cases, the cause of the limitation is seen in the distribution of the food plant. Where the food plant is scattered and grows equally well in nearly all localities, like the thistle, there you may look for the butterflies whose caterpillars feed upon these plants, such as the thistle butterfly. But this is by no means so absolute in some cases as in others, and there are a few species feeding upon special plants of narrow distribution which are exceptionally local in their character. Thus the snake-head, growing only in marshy, boggy spots, nourishes *Euphydryas phaeton*, which one will rarely find flying a dozen rods from where the plant grows. Others again may have other limitations, like our White Mountain butterfly, which, although the sedges, which are its favorite food, occur all over the upper surface of the mountains and even below the timber line, nourish the caterpillar only in the upper section of the barren summits.

It follows from this that our cultivations have made much havoc with our butterflies, for as one spot after another, especially such as may nourish the moisture-loving plants, is brought under drainage and cultivation, the plants, unable to find in the immediate proximity any suitable station, become for that locality extinct and with them the butterflies depending

on them for food. So, too, in an opposite way, by the accidental or intentional flooding of such a locality, the butterfly may again perish and sometimes also the food plant. Thus Mr. Edwards remarks of *Euphydryas phaeton* that it absolutely disappeared for four or five years from a swamp in the neighborhood of his residence after a disastrous and long continued flood of the Kanawha River, and was only restored to its old home by artificial restocking.

Of all our butterflies it is probable that the Melitacidi and many of the Chrysophanidi are the most local, the Vanessidi and Papilionidae the least so, though this statement should by no means be taken too literally; the exact relation of this localization to the distribution of the food plant can only be properly discussed when the food plants of our caterpillars are better known, and then by one as familiar with the plants as with the butterflies.

EPIDEMIA EPIXANTHE.—The purple disk.

[The purple disk (Gosse); Epixanthe butterfly (Harris); marsh copper (Scudder); brown copper (Maynard).]

Polymnatus epixanthe Bois.-LeC., Lép. Amér. sept., 127, pl. 38, figs. 4, 5 (1833);—Morr., Syn. Lep. N. Amer., 85 (1862).

Chrysophanus epixanthe Westw.-Hewits., Gen. diurn. Lep., ii: 498 (1852);—Fern., Butt. Me., 88 (1884);—French, Butt. east. U. S., 282-283 (1886);—Mayn., Butt. N. E., 41-42, pl. 5, figs. 53, 53 a (1886).

Lycaena epixanthe Harr., Ins. inj. veg., 3d ed., 274 (1862).

Epidemia epixanthe Scudd., Bull. Buff. soc. nat. sc., iii: 128 (1870).

Polymnatus amictus Bois. MS.; Doubl., List Brit. mus., ii: 55 (1847).

Figured by Glover, Ill. N. A. Lep., pl. 23, figs. 14, 15; pl. F, fig. 4, ined.

Men, like butterflies,
Show not their mealy wings but to the summer.

SHAKESPEARE.—*Troilus and Cressida*.

I'll make one in a dance.

SHAKESPEARE.—*Love's Labour's Lost*.

Imago (5:5, 7). Head covered with black, mixed with brownish fulvous hairs, the latter especially on the summit; behind the eyes covered with black scales, but next the eye itself a band of white scales, narrow above, broad below; in front and about the antennae exactly as in *H. hypophlaeas*. Antennae black, the base of each joint of the stalk annulated narrowly (on the outer surface broadly) with white; basal half of the under outer surface of club white; beneath dull orange castaneous, the apical two or three joints orange luteous above. Palpi, excepting the apical joint, white, a few black hairs in the otherwise white fringe below, more abundant apically, the apical half of the middle joint above, and the apex at the sides black; apical joint black, excepting the white under surface, tipped minutely with white. Tongue blackish testaceous.

Thorax covered above with dark yellowish brown hairs, beneath with white hairs. Legs white, the tarsi sometimes dirty white, the apical joint of the tarsi and the basal two-thirds of the other joints, excepting the first, blackish brown above, the tarsal joints brownish yellow below; spines black; claws dark red.

Wings above: *Fore wings*; second superior subcostal nervule arising at three-fifths

the distance from the base of the first nervule to the apex of the cell, in the male; third arising less than midway from the tip of the cell to the apex of the wing in both sexes. Either dark chocolate brown, with a slight olivaceous tinge, the basal three-fifths, excepting the costal and inner margins, tinged with bright, rosy violet, deepest next the base, best seen by reflected light, the separation between the bright and dark colors being very vague, passing midway between the apex of the cell and the outer border above, farther inward below, the veins dark brown (♂); or, dark gray brown, the outer margin narrowly bordered with a slightly darker tint (♀); costal edge very dull orange; a small, black spot just beyond the middle of the basal two-thirds of the cell, in the female only; a small, black spot in the middle of the outer two-thirds of the cell; another similar one directly beneath it, in the medio-submedian interspace; another, larger, transverse spot bordering the extremity of the cell; in the female only, a transverse, bent series of seven similar spots, just beyond the middle of the wing, the upper four, above the median nervule, in a nearly straight line directed downward and a little outward from the costal border at two-thirds the distance from the base; the lower of these four is situated a very little less than half way from the apex of the cell to the outer margin; the lower three spots, in the median and medio-submedian interspaces, are arranged in a nearly straight line, subparallel to the outer border, directed toward the middle of the upper series, and about at right angles to the inner border; outer margin narrowly and vaguely edged with dark greenish brown; basal half of fringe of about the same color, apical half pallid. Outer margin of *hind wings* uniform and continuous, the wings themselves either dark chocolate brown, the middle of the basal two-thirds tinged, more faintly than on the fore wings, with violet (♂), or dark gray brown (♀); a blackish dot in the middle of the outer half of the cell, in the female, a similar one just above and just below it in the neighboring interspaces; the termination of the cell marked by an obscure blackish streak; an extra-mesial series of seven small, obscure, blackish spots (in the male usually partially obsolete), that in the costo-subcostal interspace situated midway between the inner spot of the female and the outer border; the next, outside of it, just before the middle of the upper subcostal interspace; those in the next two interspaces, midway between the apex of the cell and the outer margin, those in the three succeeding interspaces in a slight curve opening inward, the middle one just beyond the centre of the lower median interspace; a submarginal, crenate streak of orange starts from the very tip of the inner margin, where it is broad, and passes in a series of linear lunules, just keeping free of the outer margin and decreasing in size gradually, to the lower or even the middle subcostal nervule; it often reaches no further than the upper median nervule, and sometimes is mostly confined to an orange spot at the extreme tip of the inner angle; outer margin narrowly and vaguely lined with blackish, the basal third of the fringe very dark; beyond, paler than the same part of the fore wings.

Beneath, dull, greenish, pale straw yellow, a little brighter along the outer border, and deepening to orange along the costal edge of the fore wings. *Fore wings*; all the black markings of the upper surface of either sex are repeated in each sex beneath, and, in addition, a spot in the medio-submedian interspace, beneath the basal spot of the cell, and a submarginal row of pretty large, blurred, dusky spots on the lower half of the wing, distant an interspace's width from the outer border, sometimes obscurely edged outwardly with orange; fringe of the color of the under surface. *Hind wings* with two nearly straight but slightly curving rows of three black, dot-like spots, each in the basal half of the wing, the middle spot of each situated in the cell at a little beyond the middle, one of the basal, the other of the apical two-thirds, the upper spots in the costo-subcostal, the lower in the medio-submedian interspaces, the latter at equal distances on either side of the first divarication of the median nervule; the tip of the cell is faintly marked with a fuscous line; there is a slightly irregular, bent, extra-mesial series of eight black, dot-like spots; the upper four, above the median nervule, in a nearly straight line (the third just outside of it), that in the costo-subcostal interspace being removed outward from the first subcostal divarication.

cation by the width of an interspace, and marking, with the other spots of the interspace, equal distances from the base of the wing; that in the subcosto-median interspace is a little less than half way from the tip of the cell to the outer border; the fourth, with the sixth to the eighth, form a nearly straight line, curved very slightly outward, parallel to the outer margin, the spot in the medio-submedian interspace being nearly as far removed from the neighboring spot in the same interspace as that is from the base of the interspace; the fifth spot, in the upper median interspace, is removed somewhat inward from the curve; the submarginal series of continuous orange lunules of the upper surface is repeated beneath, extending almost entirely across the wing, becoming fainter and slightly farther removed from the outer border in its course from the inner border upward; it is margined above with pale, obscure silver, often assuming the form of slight, sagittate spots; fringe pale, fuscous-argenteous, darkest at base.

Abdomen blackish above, with a violet lustre; beneath, whitish, tinged very slightly with straw-color. Appendages of male (34:36) with the lateral alations of upper organ bent abruptly downward with an appressed face before the middle, the drooping portion gently tapering in its apical half to a rounded point; lateral arms a little expanded on their distal horizontal half, the pointed apex upturned. Claspers elbowed at the bullate base; beyond, the blade is many times longer than broad, expanded slightly before the tip, which is pointed and turned a little inward and upward.

Measurements in millimetres. Length of tongue 4 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	12.75	12.75	13.5	12.	12.75	12.75
antennae.....	6.75	6.75	6.75	5.8	6.5	6.5
hind tibiae and tarsi.....			4.	3.6		
fore tibiae and tarsi.....			2.9	2.9	2.9	2.9

Described from 32♂, 8♀.

A pair from Canada (Saunders) differ from others seen in having the under surface of the hind wings of a paler, more silvery tint.

Accessory sexual peculiarities. Besides the different markings of the upper surface of the wings, the male has here some untoothed scales to be probably regarded as androconia (46:35); these are quadrangular, with gently convex sides, broadly rounded tip, and basal lobes of unequal width, the striations closely crowded and parallel; they are slightly asymmetrical and nearly three times longer than broad.

Egg (65:16, 23). Completely covered with minute, deep, circular pits averaging .042 mm. in diameter and .0125 in depth, somewhat regularly disposed on the sides in oblique rows, running at about an angle of forty-five degrees with the base; above, the rows become confused and irregular, and on the summit the cells alter in shape and size until they nearly vanish. Micropyle pit .085 in diameter and .05 mm. deep; the rosette (68:11) occupies the whole floor of the pit, and the cells seem to be partially concealed by the high and perhaps overhanging walls; the central cell is circular, .002 mm. in diameter, and surrounded by four large cells, which are nearly circular, being .017 mm. long in the axis turned toward the centre, and .021 mm. in the transverse axis; the outer cells are nearly circular, .015 mm. in diameter; the walls bounding the cells are delicate but distinct. Color milk white. Height, .475 mm.; breadth, .84 mm.

Caterpillar. *First stage.* Studied only from a specimen that had died within the egg, which would seem to show that it was dull yellow in nature. Head fuscous. Bristles pale; the longest upper bristles are .4 mm. in length, and the spicules excessively minute; the lateral bristles are only .14 mm. long and .0065 mm. in diameter at base, the spicules comparatively conspicuous, near the base of the bristle being as long as half the diameter of the bristle. Apparent length of body, .8 mm. Head (79:41) about .2 mm. wide.

Comparisons. This species has often of late been considered as iden-

tical with the more northern form described under the name of *dorcas*. They are certainly very nearly allied, but *E. dorcas* differs from the present species in the following particulars: The upper surface of the wings of the male is much less brilliant; all the dark spots that appear on the upper surface of any of the wings of the female, are present quite as distinctly in the male, excepting the basal spot of the discal cell of the fore wings; and these spots, or at least those of the extra-mesial row of the fore wings, are followed in the female by a broad orange flush; the outer bordering is not so broad as in the present species; and the tint of the whole under surface is different, being of a decidedly rusty yellow, perhaps a little deeper in the female than in the male.

Distribution (25:2). This species is confined to the northern half of the Alleghanian and the southern part of the Canadian faunas, from the Atlantic westward to the Mississippi. To the north it occurs in Newfoundland (Brit. Mus., Gosse), Cape Breton (Thaxter), Quebec (Bowles), Montreal, generally very rare (Lyman), Ottawa, abundant (Fletcher), London, Ont. (Saunders), Michigan (Mus. Mich. Univ.) and Minnesota (Edwards); besides which I find a memorandum of its occurrence in Iowa and Nebraska, and Edwards credits it to Kansas. These last localities were overlooked when the map was made. It has even been taken at Calgary (Geddes). To the south it is reported "neither common nor rare" at Philadelphia (Blake), but with this exception and New York (Lintner), the New England localities are the only ones known.

Here, in opposition to the species of *Chrysophanus*, it has only been found east of the Connecticut valley with the single exception of New Haven. It has been found about Orono, Me. (Fernald), at Milford "very plentiful in a few localities" (Whitney), Suncook, "not common" (Thaxter) and Hampton, N. H., abundant (Scudder), and in Massachusetts at Andover (Sanborn, Clapp), the great meadows between Belmont and Lexington, "abundant" (Thaxter), Malden, "hundreds" (F. H. Sprague), Newton (Faxon, Minot), West Roxbury (Faxon), Cambridge and Milton (Harris) and Walpole (Guild).

Haunts. One reason for its apparent absence from districts where it must occur is its extreme localization. It never wanders from the cranberry bogs or peaty meadows where its earlier, humbler life was passed, although its ally, *Heodes*, may abound upon the roadside plants in the immediate vicinity. When once its favorite haunt has been discovered, it may be taken at the proper season in large numbers.

Food plant. The food of the caterpillar is unknown. Mr. W. Saunders suggests that it may be *Menyanthes trifoliata* Linn., since the butterfly is abundant where that occurs; but it seems more probable that it feeds upon some of the *Polygonaceae* which grow in marshy soil, such

as some species of *Persicaria*, or perhaps the swamp dock, *Rumex verticillatus* Linn. See, however, the next paragraph.

Life history. It appears to be single brooded. The earliest butterflies appear the last of June—about the 25th, and they become abundant during the first week in July, but are evidently still emerging from the chrysalis during the third week in July and may be found until at least the end of the first week in August. In Quebec Mr. Bowles has found them only in August, but at Ottawa, Mr. Fletcher has found them abundant by July 1. The eggs are laid after the first week of July, but the subsequent stages are altogether unknown; as eggs obtained by Mr. Saunders were laid only on the cover of the chip box in which they were confined, it is probable that the female deposits naturally on the under surface of leaves or twigs. As none of these eggs, laid July 8, ever hatched (though the caterpillars formed within), and the butterfly appears but once a year and then as late as July, it is probable that the eggs do not hatch until the succeeding spring, in which case they would certainly not be laid upon leaves of herbs but upon stems or twigs of some woody shrub. It may, therefore, well be doubted whether they feed upon *Polygonaceae* at all. Possibly we should look instead to some of the neighboring family, *Lauraceae*; Gosse says he met with it in Newfoundland "chiefly on some low shrubs, unknown to me, whose leaves have an aromatic odor somewhat like that of the orange tree." Could he have had Benzoin in mind? It is a frequenter of suitable localities for this insect.

Habits and flight. The butterfly flies very near the ground and frequently alights on sumac and cranberry; Maynard calls it "quite sluggish," but Saunders observes that the butterflies soon become much worn by frequent combats and speedily diminish in numbers. Nevertheless it is a far less active insect than *Heodes hypophlaeus*, which it much resembles in appearance, flight and attitudes. It is thought by some that it is far more abundant in some years than in others.

Desiderata. The local habits of this insect render our knowledge of its geographical distribution very unsatisfactory; of its earlier stages we know nothing except the structure of the egg and the probability of its hibernation. It would be almost vain to search for the caterpillar in any spot where the butterfly had not been observed; and as a first step to a knowledge of the early stages, the discovery of the food plant is essential. The above account of the appearance of the butterfly rests upon far too meagre data, for the insect may prove to be double brooded; a single specimen taken in Hampton on July 8 was greatly worn, while large numbers found July 22 were in very fair condition,—facts which certainly look in that direction. The parasites of the insect and the flight and postures of the butterfly also need investigation.

LIST OF ILLUSTRATIONS.—EPIDEMIA EPIXANTHE.

General.		Imago.	
Pl. 25, fig. 2.	Distribution in North America.	Pl. 5, fig. 5.	Female, upper surface.
Egg.		7. Male, both surfaces.	
Pl. 65, fig. 16.	Colored.	34: 36.	Male abdominal appendages.
23.	Plain.	39: 22.	Neuration.
68: 11.	Micropyle.	46: 35.	Androconium.
Caterpillar.		55: 9.	Side view with head and appendages enlarged, and details of leg structure.
Pl. 79, fig. 41.	Head, first stage.		

HEODES DALMAN.

Heodes Dalm., Vet. acad. handl., xxxvii: 63, 91 (1816).	Lycæna (pars) Auct. plur. Chrysophanus (pars) Auct. Type.— <i>Papilio phlaeus</i> Linn.
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Blumen ohne Zahl! De Summer-Vögel that d' Wahl web.
HEBEL.—Die Wiese.

Imago (55: 10). Head moderately small, densely clothed with scales, which are elevated to high tufts behind the antennae, and furnished also with numerous hairs, above very long and arching forward, behind longest and downward, in front rather long, diminishing in length downward. Front flat, above a very little sunken down the middle, and at the upper extremity a distinct, narrow, rather shallow, longitudinal groove; on the lower two-thirds a little full down the middle, at the bottom slightly tumid, barely surpassing at a single point the front of the eyes; less than half as high again as broad, of the width of the eyes as seen in front; upper border not raised, the corners considerably hollowed in front of the antennae; lower border rather broadly rounded, the sides straight. Vertex scarcely elevated in the middle, laterally buttressing the antennae, well separated from the occiput by a deep, pretty deep, transverse, nearly straight sulcation, deepest in little pits in the middle and behind the antennae; occiput slightly but broadly sulcated along the middle longitudinally. Eyes not very large nor full, naked. Antennae inserted with their posterior edge in the middle of the summit, separated from each other by a space equal to the width of the second antennal joint; half as long again as the abdomen, composed of thirty-one joints of which twelve form the strongly depressed, elongated club, which is about three times as broad as the stalk, four times as long as broad, the first four or five joints increasing very gradually in size, beyond which the club is equal and terminates by the rapidly decreasing size of the last two or three joints, which form a very short but pointed cone. Palpi very slender, rather less than half as long again as the eye, the apical joint fully half the length of the penultimate, clothed only with recumbent scales, while the rest are densely clothed with erect scales, much the longest beneath and thinly fringed below with long, straight hairs projecting forward and upward.

Patagia comparatively broad and oval at base, the posterior half forming an equal, slender, straight, very bluntly pointed lobe, scarcely one-third as wide as the base; the whole is fully three times as long as broad, the inner border slightly hollowed just before the middle, the outer deeply, at the base of the posterior lobe.

Fore wings (39: 21) three-fifths as long again as broad, the costal margin bent and slightly convex in the middle of the basal third, beyond very nearly straight, the tip scarcely curved downward, the outer angle abrupt, but rounded off; outer border slightly and regularly curved, inclining at an angle of about 75° to the costal margin; inner margin scarcely hollowed and angulated at the middle, the outer angle rounded off. Costal nervure terminating at the tip of the cell; subcostal with three superior branches; the first arising at the middle of the outer four-fifths of the cell; the second midway between the origin of the former and the apex of the cell; the third at or barely

before the apex of the cell, forking midway between the base of the nervule and the end of its upper branch; cross veins transverse, obsolete, scarcely perceptible even next the main veins; cell half as long as the wing and nearly four times as long as broad.

Hind wings considerably and roundly expanded next the base, beyond, fully half way to the tip, scarcely convex, then curving downwards rather rapidly and somewhat abruptly (σ), or roundly and not to so great an extent (φ); outer border broadly rounded, very slightly produced and angulated at the lower median nervule, slightly and roundly emarginate in the medio-submedian interspace; inner margin broadly expanded at the base, beyond scarcely convex, slightly bent just before the straight apex, the angle abrupt and scarcely rounded. Submedian nervure terminating on the outer border, just beyond the anal angle; internal nervure terminating considerably beyond the middle of the inner margin.

Foretibiae five-sixths the length of the hind tibiae (φ), or scarcely shorter than they (σ), the spurs naked; fore tarsi fully as long as (φ) or a little shorter than (σ) the tibiae; the last tarsal joint either similar to the same part in the other legs (φ); or small, tapering, armed with only a stout, apical, tapering spine, which differs from the other spines of the under surface which crowd up to it only in size, and furnished above with very short and dense hairs instead of scales (σ). All the femora provided with a fringe of rather close, long hairs on the under surface. Middle tibiae as long as (σ) or a little shorter than (φ) the hind tibiae; armed beneath with rather short and slender, scattered spines and apically with a pair of rather long and stout spurs, only the tip bare. First joint of middle and hind tarsi rather strongly gibbous in the male; in the female of the usual appearance, considerably more than equalling in length all the other joints combined; second, third and fifth joints about equal, the fourth smallest; joints armed beneath rather profusely with rather long and slender, scattered spines, mostly collected in crowded rows at the sides, an apical pair on each joint a little longer than the others, the under surface devoid of scales, excepting on the first joint; claws small, compressed, not stout, tapering, finely pointed, falcate, but not very strongly curved; paronychiae double, the superior lobe as broad at base as the claw, nearly straight, considerably exceeding the claw in length, the tip enlarged and very broadly rounded, almost docked; inferior lobe moderately slender, equal, the tip pointed, about as long as the claw and curving considerably both toward the claw and inward; pulvillus inconspicuous.

Male abdominal appendages with the lateral flaps of the upper organ forming bent and equal cylinders, the proximal halves parallel and enclosing between them a deep and equal mesial cleft, the distal halves bent downward and outward; lateral arms strongly arcuate but not bent; clasps coarse, stout, bullate, several times longer than broad, well rounded.

Egg. Demi-echinoid in shape, the base being very broadly docked, flat, not curved at the edge, from which it is very broadly arched, not high; the cells are very large and conspicuous, bounded by heavy, elevated walls, are irregular in outline, but disposed in obscure, irregular, horizontal and oblique rows; the cells are smallest at the base, increase in size upwardly, largest on the upper portion of the sides and decrease again at and around the summit. Micropyle rosette lying on the floor of an infundibuliform cavity and composed of minute cells, bounded by low, heavy walls.

Caterpillar at birth. Head broadest at summit, the sides as far as the bottom of the ocellar field tapering a little, scarcely convex; below tapering rapidly, the lower surface broadly rounded, crown of hemispheres broadly rounded, rather deeply and broadly cleft between them. Body largest at anterior extremity, tapering a little on the thorax both as seen from above and from side, very slightly on the abdomen; posteriorly well rounded, above a little depressed, below greatly flattened, much as in the mature forms of the family. First thoracic segment furnished with a transverse, double row of very long hairs curving strongly forward over the head; remaining segments furnished as follows: first, a subdorsal row of hairs seated on high and slender papillae, two on each segment, one central and exceedingly long, curving backward, and, when viewed posteriorly, curving first outward and upward and then upward and

inward, tapering very slowly to a fine point, anteriorly very minutely spiciferous, the other posterior and a little outside the former, not very long, nearly straight but turned backward, tapering, slender, finely pointed, apparently smooth; second, a ventrostigmatal row of hairs seated upon rather high papillae, three on a segment, long and slender, quite straight, turned a little backward, very minutely spiciferous on both sides, finely pointed; third, a laterostigmatal series of large, circular, crateriform papillae or annuli, one in the centre of the first to sixth abdominal segments, and a similar papilla on the seventh segment in place of the smaller and outer subdorsal hair; fourth, an infrastigmatal row of smaller, but still pretty large papillae, one in the centre of the first to eighth abdominal segments and immediately behind them a minute, supplementary, posterior wart. Legs not very long, but moderately slender, the last joint tapering, the claw pretty stout, not greatly curved. Prolegs nearly sessile, the circle of hooklets very large, forming a circle or oval, open laterally, nearly as long as the segment and containing ten very minute, but not very tender, moderately curving claws, separated from each other by a space more than equal to their thickness.

Mature caterpillar. Head small, smooth, well rounded, broadest just below the summit, no broader than high, very slightly full on the sides at the broadest point and at the ocellar field, deepest in the middle but scarcely narrowing above, the front broadly rounded on a lateral view, the triangle large, scarcely higher than broad but reaching two-thirds way up the front, the sutures a little impressed; a few hairs on the triangle, labrum and lower part of the head. Antennae long, the basal joint prominent, longer than broad, moderately stout, tapering, the second cylindrical, as large as the apex of the first but only a little more than half as long as broad; the third as broad as the second, increasing a little in size at the apex, nearly twice as long as broad, the fourth minute, conical, sharply pointed. Ocelli six in number, four of which are placed close together, the lower two a little more separated than the others, in a strong curve, the arc of a small circle, its convexity forward, whose centre is occupied by the fifth ocellus; the sixth is placed below the others, a little outside of the extension of a line connecting the lower two of the curve and as far from the lowest as that is from its neighbor; the central ocellus and the middle one of the anterior five are the largest, the lowermost the next and the others equal. Labrum large, broad, longitudinally rugose, its front border very broadly, roundly, and but little excised. Mandibles slender, not broad, their edge oblique, very deeply dentate, the teeth being long and very slender, tapering, sharply pointed, rather distant, five or six in number, and the space between adjoining ones roundly, deeply excised. Maxillary palpi with the joints about equal in length, growing successively smaller, cylindrical, the terminal conical; inner palp resembling the terminal joints of the outer but smaller; spinneret conical, short, rather slender.

Body regularly, equally and considerably arched from one extremity to the other; the separate segments also rather prominently arched, especially in the middle of the body and therefore quite distinct; viewed from above elliptical, the front end rounded a little more bluntly than the hinder extremity, scarcely tapering posteriorly. Dorsal field scarcely if at all depressed, but strongly arched and elevated on a cross section. Body very delicately and closely shagreened, covered with numerous, irregularly scattered, equal hairs, arising from nearly imperceptible warts, the hairs short, scarcely tapering, bluntly pointed, frequently and minutely though coarsely spiciferous, the raised points scarcely directed toward the tip of the hair, but almost perpendicular to the surface of origin. Spiracles small, obovate, more than half as long again as broad. Legs short but rather stout, tapering rapidly, furnished on the inner side with bristles, the last joint rather slender and appressed, the claw rather long, compressed, holed, moderately slender, curved a little, supported on either side by a long bristle. Prolegs very short and plump, furnished at the tip with a couple of short pads, each supplied with 12-14 hooklets, arranged in a double row so that all those of one proleg form an open crescent; the hooklets are long, moderately stout,

tapering on the apical half, bluntly pointed, not strongly curved, distant from one another by fully twice the diameter of one of them.

Chrysalis. Very little more than twice as long as broad; the sides of the body from one extremity of the wings to the other straight, or with a barely perceptible hollowing next the division line between thorax and abdomen, very slightly divergent posteriorly, so that the body is broadest at the fourth abdominal segment; here it is somewhat angulated, the posterior end tapering at once and forming an elliptical curve, the tip well rounded. In front of the wings the body tapers rapidly and has a rounded, scarcely appressed front, the basal wing prominence being marked only by the angle the front part of the body makes with the wings. Viewed from the side the flat bottom is uniform throughout; the posterior third of the thorax is very nearly equal, but slopes forwards a very little, its hindmost extremity a very little the most elevated, roundly angulated in the middle of the posterior two-thirds and sloping in front of it downward and forward about equally, scarcely curved. Abdomen very broadly arched above, highest and a very little higher than the thorax at the third segment, beyond the fourth segment with a pretty strong, downward curve, the lower edge of the eighth segment being the most posterior point, the whole of the ninth segment directed forwards; the downward curve at the posterior is much more rapid than at the anterior extremity of the body. Transversely the middle of the thorax is well arched, the sides sloping away from each other at an angle of about 70° , with a scarcely perceptible hollowing, the summit rather broadly rounded; abdomen regularly rounded, forming an almost exact semicircle. More than three-fifths of the tongue exposed. Body covered equally with a very delicate tracery of slightly raised lines crossing each other irregularly, and on the wings forming elongated, irregular, oval cells; at other places there is a little wart at the intersection of the lines; the surface within these cells is not infrequently occupied in part by an independent wart of similar size giving rise to a fungiform papilla (86:33), the basal two-thirds of the pedicel slender and equal, the apical third rapidly expanding to a wine glass-shaped disk, hollowed above, the horizontal edges of which are fringed with fleshy pointed ciliae. Hooklets pretty long and exceedingly slender, the stem equal, straight on basal, slightly curved on apical half, the expanded portion fully four times as broad as the stem, bent strongly over but not at all appressed to the stem, as the upper portion of this is curved, transverse, the sides turned backward considerably.

This genus of *Chrysophanidi* belongs to the northern hemisphere and encircles the globe; one (or perhaps more) species extends across the whole width of the Old World and reaches from its northernmost coasts to at least Lat. 30° , and even as far south as Abyssinia in Africa and northern India in Asia. In Switzerland it is said by Meyer-Dür to be most abundant between 1800-2500 feet above the sea; another—the species with which we are specially concerned—inhabits the New World, spreading also from ocean to ocean, but confined to a much narrower belt, for it has rarely been found north of Lat. 47° and except in mountainous regions seldom far south of Lat. 40° . It is common throughout New England.

The butterflies of this genus are of rather a small size; the fore wings are somewhat pointed at the apex and the hind wings, having the outer border straighter than usual, present rather a quadrate appearance; the tip of the lower median nervule is very slightly produced. The upper surface of the fore wings is of a fiery red, the outer border blackish brown; this is reversed on the hind wings, although on these the red border is in-

terruted by dark marginal spots; the fore wings are also furnished with two black bars in the cell and an extra-mesial series of similar oblique bars. Beneath the color is light brown, tinged on the disc of the fore wings with red and furnished with the spots of the upper surface; the hind wings are traversed by a submarginal, sinuous red stripe, an extra-mesial sinuous and an intra-mesial straight series of small, black spots, besides a pair of basal spots and a transverse streak at the tip of the cell. "It is remarkable," says Westwood (*Gen. diurn. Lep.*, ii: 498), "for the dilated basal joint of the fore hind tarsi of the males."

Even the lovers of nature shut up within the walls of our large cities can enjoy in any public park a sight of these ubiquitous flutterers, can watch them in their hymeneal dance as they toss themselves up and down in contra-unison and then flutter away to repeat the sport in another spot. They heed not the approaching footstep until it is just upon them—fearless little brilliants, familiar objects of the civilized world.

The butterflies are double or triple brooded, appearing first in May and continuing on the wing throughout the whole of the season; the majority doubtless hibernate in the chrysalis state, but occasionally they may survive the winter as caterpillars. They fly in the sunniest places, frequenting dry pastures and roadsides, moving about in short flights from place to place, frequently alighting, but quickly darting away again to attack some passing insect. The transformations of the species are fairly well known.

The eggs are very characteristic in form, being semi-echinoid covered with large, shallow pits having moderately heavy walls.

The young caterpillars are largest in front, taper slightly and are flatter than at maturity; they are furnished with very conspicuous subdorsal rows of exceedingly long, stout, tapering bristles, each nearly as long as the body and curving strongly backward, besides a series of numerous, shorter, nearly straight bristles below the spiracles.

The body of the full grown caterpillar is pretty regularly arched and each segment somewhat domed; the body is covered with minute hairs, and is of a nearly uniform green color, but with darker, sometimes reddish, dorsal and ventrostigmatal bands. The head is always concealed by the overhanging first thoracic segment, and a median notch in the margin of the latter, seems, says Buckler, "well adapted to receive and steady the edge of a sorrel leaf whilst the larva is feeding."

The chrysalids are of a nearly uniform dull brown; they are plump, not strongly constricted between the thorax and abdomen, the whole body about twice as long as broad and covered rather abundantly with minute fungiform appendages having fringed discs.

EXCURSUS XXXVIII.—PSYCHOLOGICAL PECULIARITIES IN
OUR BUTTERFLIES.

One summer night, which I never can rue,
I dream'd a dream that turn'd out true;
I thought I stray'd on enchanted ground,
Where all was beauty round and round;
The copse and the flowers were full in bloom,
And the breeze was laden with rich perfume.
There I saw two golden butterflies,
That shone like the sun in a thousand dyes;
And the eyes on their wings that glow'd amain,
Were like the eyes on the peacock's train.

I did my best
To steal on their rest,
As they hung on the cowslip's damask breast;
But my aim they knew,
And shier they grew,
And away from flower to flower they flew.
I ran—I bounded as on wings,
For my heart was set on the lovely things,
And I call'd, and conjured them to stay,
But they led me on, away, away!
Till they brought me to enchanted ground,
When a drowsiness my senses bound;
And when I sat me down to rest,
They came and they flutter'd round my breast;
And when I laid me down to sleep,
They lull'd me into a slumber deep,
And I heard them singing, my breast above,
A strain that seem'd a strain of love:—
It was sung in a shrill and soothing tone,
By many voices join'd in one.

HOGG.—*A Greek Pastoral.*

WHEN I first mentioned to a club of friends my intention to write an essay on this subject, a scornful laugh greeted me, as if I were testing their credulity. Yet no one, I fancy, could be a close observer of butterflies without noticing that, while there is no great difference between healthy individuals of the same species, there is as great a variety of temperament between different kinds as there is between different sorts of quadrupeds, to write an essay on whose psychological characters would excite no special comment; for the timidity of the hare, the cunning of the fox, the ferocity of the wolf and other psychical characteristics of various beasts have become proverbial.

In their relation to man one recognizes a great difference between butterflies as to how companionable they may be. According to some writers, there would seem to be a certain variation among the same kinds in different places, just as with other animals, according to the frequency with which they come in contact with man. Thus DeCandolle remarks that in the Swiss Alps the butterflies have no fear of man and readily settle on the colored dresses worn by the women, while on the better inhabited plains they are not known to do any thing of the kind. Their fear of man or their boldness is to a certain degree dependent upon their power of flight, as Belt has remarked in his "Naturalist in Nicaragua," the swiftest and strongest flyers allowing one to approach much nearer than those with weaker wings, feeling confident that they can dart

away from any threatened danger. Yet entirely apart from this, one may roughly divide butterflies into domestic and feral according to their habits and sympathies. Thus among the feral tribes should be ranked nearly all the Satyrinae, and especially such forms as *Oeneis jutta*, *Enodia portlandia* and *Cissia eurytus*, and among the companionable sorts nearly all the species of *Vanessidi*. Instances of the boldness and even friendliness of the latter are not uncommon. "While I lingered here," says one of our happiest describers of the habits of beasts and birds, "a pretty butterfly, the red admiral, alighted upon my knee as I was writing, and seemed wholly at ease in this unusual position. Something upon my clothes was attractive to it, and the graceful movements of its proboscis, and occasional down-dipping of one antenna and then the other were amusing. I noticed that the right and left wing moved separately down and up, as though to retain the creature's balance, which the wind threatened, and at each such movement of the wings, the corresponding antennae likewise dipped. This butterfly occasionally flew to the bushes near by, but never to remain long away, and sooner or later returned and was my companion for a great part of the day." (Abbott, *Waste land wanderings*, 79). The pages of the present work contain many instances of the vivacious and inquisitive ways of these butterflies. The entomologist cannot fail to be aware of them. Seeing one alight upon the tip of a bough near by he strikes at it with his net, only to see it fly off in an apparent paroxysm of terror, while if he but stop a moment, he will see the runaway return, dash about him and alight again upon the selfsame spot in a defiant way, flirting its wings up and down, as who should say "Try it again, will you?" For there is much that is sportive as well in the ways of many butterflies. One of my favorite modes of showing this characteristic to unbelieving friends has been to toss my cap high in the air, when these butterflies will often dart, dash at and play around it as it begins again to descend. DeGarmo has noticed this characteristic, as witness the following passage:—

"One of the most curious features of a butterfly's life is its sportive or playful moods and ways. It was some time before I appreciated the fact that they indulged in such moods at all. Seeing them start vigorously after other insects on the wing, I assumed without investigation that these were movements in self defence, till all the facts pointed to them as movements in play. This opened a new and interesting field of observation. The spirit of playfulness I found to prevail more towards sundown than in the morning. Only a very few times have I seen any signs of it in the morning and never in the absence of sunshine. I found it far more common among the highly developed four-footed butterflies, as the *Graptas*, *Vanessas*, etc., than among the six-footed *Papilios*. . . The greatest manifestation of fun and frolic was in a group of *alopes*, some thirty in number, clustered under a tree in the shade. Such wild gambols on the wing

I never saw, often in one compact cluster, wings and legs and antennae in a confused jumble, then off in pairs, then in two crowds, with all the marks of 'mirth and jocund din.' Such scenes do certainly appear like an intelligent appreciation of fun, as they clearly have no reference to any necessary functions of body, and seem intended only for gratification." (Trans. Vassar. br. inst., ii: 133-134.)

It is but a short step from these characteristics to that of pugnacity, which is manifested by none of our own butterflies so conspicuously as by *Heodes hypophlaeas*. Watch one on a hot and sunny day in a favorable place, and you will see the fellow dart at every passing object, be it butterfly large or small, or even a blundering grasshopper. So, too, *Junonia coenia* has been described as "a most pugnacious little creature, and appears to love a quarrel, for you may see three or four of them ascending in the air and buffeting each other, now rising, now falling, unremittingly continuing their aerial warfare." (Jones, Nat. in Berm., 120).

How totally different this from the sluggish, lazy, easy-going manner of most of the satyrids, with their dainty ways, tossing themselves in graceful throws in and out the shrubbery; or the hurried direct way of the species of *Argynnis*, or better of *Eurymus*, zigzagging from spot to spot as if on business of the greatest urgency, though not quite certain where it was; or the bustling self-important actions of the larger skippers. Even in the butterflies of wilder spots, less frequently seen, how great a difference between the timid *Pieris oleracea* which, though it feeds upon the produce of the garden, will scarcely let you approach in any near proximity, and the showy *Basilarchia arthemis* that will allow you to approach and pick it up with the fingers. What a contrast between the dignified *Anosia plexippus* moving imperturbably along its own way, undisturbed by the attacks of the smaller butterflies which dash about it, and the vacillating, dainty blues which cannot make up their minds just what to do; or between the wary, artful *Oeneis semidea* and the bold and careless *Euphrocades glaucus*. How rarely one sees collected in one spot on a flower or about a moist spot more than two or three *Heodes hypophlaeas*; they are too vicious and quarrelsome to be companionable. How different the equally active but eminently social *Eurymus philodice* or *Basilarchia arthemis*, which congregate by hundreds, as do also *Euphrocades glaucus* and many others. The cunning ways of *Oeneis semidea* in its rocky defences have been mentioned in our text, and a similar wiliness appears in others, sometimes shown in a mock stupidity, as it were, flying, as you cautiously pursue, just beyond the reach of your net, moving with greater and greater swiftness as you increase your speed, all the while against the wind, when suddenly, after a quick movement upward, they open their wings to the breeze and are carried far behind you, thus evading the pursuit which they found becoming irksome, and leaving you heading the wrong way.

HEODES HYPOPHLAEAS.—The American copper.

[The American copper butterfly (Harris); small copper (Gosse); copper butterfly (Emmons); short-tailed chrysophane (Emmons); small copper butterfly (Maynard).]

Polyommatus hypophlaeas Boisd., Ann. soc. ent. Fr., (2) x: 291 (1852); —Morr., Syn. Lep. N. A., 84 (1862).

Heodes hypophlaeas Scudd., Bull. Buff. soc. sc., iii: 128 (1876); Butt., 166, figs. 4, 7, 25, 42, 58, 105 (1881).

Chrysophanus hypophlaeas Edw., Rev. cat. Lep. N. A., 59 (1884); —French, Butt. east. U. S., 283-284, figs. 75-77 (1886).

Lycæna americana Harr., MS.; Ins. inj. veg., 3d ed., 273-274, fig. 104 (1862).

Chrysophanus americanus D'Urb., Can. nat., v: 246 (1860); —French, Rep. Ill. ins., vii: 158 (1878); —Fern., Butt. Me., 89-90, figs. 27-28 (1884); —Mayn., Butt. N. E., 41, pl. 5, figs. 52, 52 a-c (1886).

Polyommatus americanus Morr., Syn. Lep. N. A., 91 (1862).

Polyommatus phlaeas (pars) God., Encycl. méth., ix: 609, 670-671 (1819); —Boisd.-LeC., Lep. Am. sept., 123-124 (1833); —Morr., Syn. Lep. N. A., 84 (1862).

Lycæna phlaeas Harr., Hitchc. Rep., 590 (1833).

Chrysophanus phlaeas Emms., Agric. N. Y., v: 216, pl. 46, fig. 4 (1854).

Lycæna phlaeas var. *americana* Streck., Lepid., 91 (1878).

Lycæna bacchus Harr. MS.

Papilio — Abb., Draw. ins. Geo. Brit. Mus., vi: 58, fig. 13 (ca. 1800).

Figured by Glover, Ill. N. A. Lep., pl. 27, fig. 13; pl. Q, fig. 4, ined.

[Not *Papilio phlaeas* Linn.]

Colon de la plaine éthérée,
Aimable et brillant papillon,
Comment de cet affreux donjon
As-tu su décourir l'entrée?
.....

Doux ornement de la nature,
Viens me retracer sa beauté!
Parle-moi de la liberté,
Des eaux, des fleurs, de la verdure;
Parle-moi du bruit des torrents,
Des lacs profonds, des frais ombrages
Et du murmure des feuillages
Qu'agite l'aéline des vents.

As-tu vu les roses éclore?
As-tu rencontré des amants?
Dis-moi l'histoire du printemps
Et les nouvelles de l'aurore.
Dis-moi si dans le fond des bois
Le rossignol, à ton passage,
Quand du traversais le bocage,
Faisait ouïr sa douce voix.

DE MAISTRE.—*Le Prisonnier et le Papillon.*

Imago (5:11; 13:5). Head covered above and down the middle with blackish brown hairs; behind, and also partly intermingling with the others, coppery fulvous scales and forward curving hairs; eyes encircled with silvery white, very broadly behind, broadly in front, excepting next and just behind the antennae, where there is a velvety black patch, the white border of the front passing, narrowly, inside the antennae and terminating just behind it; the two belts are united by an equally broad one just above the base of the tongue. Basal joint of antennae silvery white, the stalk blackish brown above, interrupted with white on the basal third or fourth of each joint, beneath, especially on the outside, almost wholly white; club black above, fuscous orange beneath, the basal half of the outside white, the apical joint, both above and below, orange, brighter in the male than in the female. Palpi, excepting the terminal joint, silvery white, the sides of the middle joint a little brownish at the apex, and with a few black hairs mingled with the white ones forming the fringe of its apical half; apical half of the same joint tinged above with coppery, with intermingled black scales, or, blackish brown with white scales; apical joint blackish brown, with some scattered white scales, especially within and beneath. Tongue black throughout, the extreme tip pale.

Thorax covered with mouse brown hairs having a metallic greenish tinge, on the inner side of the patagia bluish, on the sides of the prothorax grayish; beneath white. Femora and tibiae also white; the apical joint of the tarsi and the basal two-

thirds of the other joints blackish brown above, the sides white; beneath all but the basal joint brownish yellow, edged on either side with black; spines and spurs black; claws very dark reddish.

Above, *fore wings* brilliant orange red with a metallic coppery lustre, near the base, especially on the lower half, a very little darker; the median veins in the male dark brown; the costal border, as far as the subcostal nervure (excepting the extreme base), the outer border for the width of at least an interspace—more broadly above,—and the apical half of the inner border dark gray brown with a slight greenish tinge; in the female the costal border is only marked in this way very narrowly on its apical half, the basal half being either greenish gray, or like the prevailing color of the wing, but with a decided greenish hue. The wing is ornamented by eight straight, quadrate, transverse, very dark mulberry brown or black bars, each crossing an interspace; two are in the cell and the others form an irregular, transverse series in the middle of the outer half of the wing; one is near the middle of the cell, just over the first divarication of the median, but does not reach either margin of the cell; another borders, on both sides, the extremity of the cell; three others, the first of the transverse series, are found respectively in the two lower subcostal and the subcosto-median interspaces (and occasionally a fourth, small and obscure, in the next interspace above) forming a curving row, the interior edge of the lower one being midway between the extremity of the cell and the outer margin; and the upper spot removed inward from it by its own width; one, in the upper median interspace, is removed inward by twice its width from the one above it; and that in the lower median interspace by half its own width outward; the lowermost, in the medio-submedian interspace, is removed inward from the one above it by twice its width and its exterior edge is at twice an interspace's width from the outer border; the spot at the extremity of the cell is broader than the others, sometimes equalled by the lowermost: basal half of fringe like the outer border; apical half pallid or whitish. *Hind wings* dark gray brown, scarcely with a greenish tinge, the central portion of the basal third of the wing with more or fewer scattered, greenish coppery scales, the inner half with numerous gray brown hairs; outer border edged delicately with dark brown, followed by a broad band of orange red, broader than an interspace, extending from the inner border to the middle of the upper subcostal interspace, interrupted in the middle of each interspace by a small, round, blackish spot, occupying the exterior border of the band, or causing it to be sharply crenulate; next the slightly sinuous interior edge, in the middle of each interspace, is a faint, vague, roundish spot, slightly deeper in tint than the prevailing color, often scarcely discernible, capped by a cluster of perhaps half a dozen pale blue scales and these again by another indistinct dark spot; the extremity of the cell is marked by a narrow, blackish stripe; fringe as in the fore wings, the pale exterior half interrupted with brownish at the tip of the lower median and submedian nervules.

Beneath *fore wings* orange red, a little paler than the upper surface, without any coppery lustre; the dark spots of the upper surface are repeated beneath in velvety black, nearly as large, quite as distinct, their corners rounded, edged by a few scattered orange scales, and these by an obscure narrow encircling of white; in addition, there is a small, round spot, exactly similar to the others in character, lying in the cell, midway between the base and the extra-mesal cellular spot; the outer margin is broadly bordered, below to the width of an interspace, next the costal margin nearly or quite as far as the black spots, with brownish slate gray; in all the interspaces below the subcostal (on the upper slightly, in the others distinctly) broadly bordered with blackish, forming a stripe interrupted by the nervures; inner border, as far as the submedian, and, previous to its first divarication, as far as the median nervure, bordered with gray, enlivened by a greenish tint and a few orange scales; costal edge narrowly gray; fringe like the outer bordering, but deeper in color, with a greenish tinge along the base and paler on the outer half. *Hind wings* brownish slate gray, slightly darker in a broad border to the outer margin, especially at its interior fuscous limit at from one and a half to two interspace's distance from the margin; in the

basal half of the wing two straight series of very small, roundish black spots, the inner consisting of one in the costo-subcostal interspace very near the base, the second of one just beyond the middle of the basal half of the cell, and a third, when present, of a dot in the medio-submedian interspace, as far removed from the base as the width of the middle of the cell; the second row consists of slightly larger spots, in the same interspaces, that in the cell placed just within the middle of the outer half of the same, and the lower spot twice as far from the base of the wing as the width of the middle of the cell; as on the upper surface, the extremity of the cell is indistinctly marked by a narrow, blackish stripe. Crossing the middle of the outer half of the wing is an irregularly sinuous series of eight small, transverse or roundish, black spots, faintly bordered externally, excepting generally the upper two, with pale scales; the upper two, in the interspaces next the costal border, are placed one above the other at right angles to the border, the upper in the costo-subcostal interspace, as far removed from the outer spot of the two already mentioned in the same interspace, as they are from each other; the next three spots form the arc of a small circle opening inward, whose opposite side would strike near the extremity of the cell, that in the subcosto-median interspace being situated half-way between the extremity of the cell and the outer border; the other spots form, with the fifth, an arc of a larger circle opening inwards, whose opposite side would reach nearly or quite to the inner spot of the cell; the interior edge of the sixth spot is at the distance of two interspaces from the outer border; that of the medio-submedian interspace is double, being broken by the ground color of the wing, but its upper portion, together with the first, second and sixth spots, are the largest in the series; a wavy, submarginal line of very bright, deep orange or brick red starts from the tip of the submedian nerve, forming, in the interspace below, small, apical spots of mingled red and gray scales; it crosses the extremity of the medio-submedian interspace in an arching line, which reaches nearly half way to the black spots and then falls again to the tip of the lower median nervule; from here it passes to the middle or upper part of the lower subcostal interspace in a series of similar but much slighter arches, one to each interspace, maintaining an average distance of half an interspace from the outer border; between this carmine line and the fuscous interior margin of the outer bordering, the scales seem to be usually as light as in the centre of the wing; fringe differing from that of the upper surface, as in the fore wings.

Abdomen blackish above, dark grayish brown on the sides, whitish beneath, tinged toward the tip with dirty pale buff. Male appendages (34: 38) with the bent elongated lateral alations compressed, cylindrical, equal throughout (not well represented on the plate), rounded at tip, and somewhat swollen anterior to it, the distal half bent abruptly downward and somewhat outward; lateral arms tapering regularly to a fine point, sickle-shaped, the curve nearly equal throughout. Clasps forming a tumid subequal lamina three to four times as long as broad, broadest beyond the middle, the apical third curving a little inward, roundly truncate at tip, the upper posterior corner roundly angulate and slightly produced.

Measurements in millimetres. Length of tongue, 5-6 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	12.	13.25	14.5	13.25	14.	15.
antennae.....	6.6	7.3	8.	6.75	7.25	8.
hind tibiae and tarsi...	3.8	4.	4.25	4.	4.25	
fore tibiae and tarsi ..	2.75	3.	3.1	3.	3.4	3.5

Described from 27 ♀, 17 ♂.

Aberrations. H. H. FASCIATA. (*Lycæna phlaeas* var. *americana* ab *fasciata* Streck., Cat. Amer. Macrolep., 101—1878.) The Messrs. Faxon captured a pair of this species in Newton, Mass., August 1, within a few minutes of each other (and therefore not unlikely the progeny of one parent), which are suffused in a slight degree and almost exactly to the same extent; it affects only the row of spots in the middle of the outer half of the wing, each of which, although perfectly distinct from the others, is ex-

panded a very little exteriorly and very much interiorly, the spots beyond the cell joining that which borders the outer limits of the same, those in the median interspaces extending nearly or quite to the base of the interspaces (in one instance, the spot in the lower median interspace reaches only half-way to the base), and that of the medio-submedian interspace is, in one instance, as long as broad, and in the other twice as long as broad, instead of being, as normally, half as long as broad. On the under surface, the wings have the normal pattern.

These suffused specimens are by no means excessively rare. I have taken them myself in several places in eastern Massachusetts. Mr. F. H. Sprague has found them in Wollaston (July 10 and July 27), Mr. Roland Thaxter has taken many and Mr. Henry Edwards has a large series captured in and about Readville, all in places in the vicinity of Boston, where they appear to have been most frequently or almost exclusively noticed. I have taken one at Granby, Mass. Maynard figures one (*Butterflies N. E.*, pl. 5, fig. 52 c), and one is figured by Glover in his unpublished work (*Ill. N. A. Lep.*, pl. Q, fig. 4). In general the suffusion is caused by the basal extension of the outer row of spots on the upper surface of the front wings, which fill the whole breadth of the interspaces, often barely showing a line of tawny scales along the intervening nervules. In the most extreme cases there is a slight expansion externally, so as to approximate the broad dark band formed by the suffusion to the marginal band, but most commonly this does not occur, and usually the interspaces are less completely filled from nervure to nervure over the overrun ground so that each spot is more or less wedge-shaped, the apices pointing baseward, an appearance which gains in effect from the actual narrowing baseward of all but the two lower interspaces in which this suffusion appears. Sometimes, indeed, the suffusion is reduced to a mere enlargement of the spots of the extra-mesal row with a wedge-like tongue thrust a short distance baseward, occasionally farther on one wing than the other. Or it may be merely indicated by an enlargement of all the spots in the wing (except in the mid-cellular one, which is never affected by this or any other variation) with scarcely or no sign of any special longitudinal expansion.

The hind wing is never affected by this suffusion, or I have seen but one slight instance of it, in which the two dark spots, normally round, which are found next beyond the cell, thrust little tongues baseward; this was in the case of the most extreme suffusion observed. The under side of the wings, too, is rarely affected to any material extent, mostly confined to the brief cuneiform extension (but not in any other way enlargement) of the extra-cellular spots of the front wing. But what is remarkable is that this suffusion of the upper surface of the front wing is often correlated with obsolescence or almost complete obliteration of the extra-mesal spots of the under surface of the hind wings, and this seems to be more likely to occur the deeper the suffusion above. In one instance, however, and this the most extreme case of suffusion above—a specimen Mr. Edwards took in Readville—not only are the extra-cellular spots of the under surface of the front wings much elongated, on one side nearly reaching the cell, but the spot in the lower median interspace is also considerably enlarged; while upon the hind wing several of the extra-mesal spots, otherwise of normal size, send shoots toward the base, and the two costal spots are elongated on both wings and on one actually united into a long, subulate stripe. The same is the case to a less extent in one other specimen, while in a third, also an extreme case of suffusion above, not only are the spots of the extra-mesal row of the hind wing almost wholly (some of them wholly) obliterated, but on one side both, and on the other the inner but not the outer of the costal spots have also disappeared.

H. H. OBLITERATA. On the other hand we have another phenomenon closely connected with the above, which is the partial and nearly complete obliteration of these same extra-mesal spots of the front wing, both above and below. One such specimen is figured by Maynard (*Butterfl. N. Engl.*, pl. 5, figs. 52a) with no spots at all, but the most extreme case I have seen has some dots left. Curiously the most persistent of all the spots, whether above or below, is the upper of the two beyond the cell, which is sometimes reduced to the merest dot of black

(below, encircled with white). The two cellular spots remain unchanged. Why I connect this with "suffusion," is that in one specimen, in which on the upper surface the extra-mesal spots are reduced to obscure dots, with the exception of the lower median spot of the left wing, the under surface shows these spots also partially, though less, obliterated, and the lower of the two extra-cellular spots of the right wing (invisible without a lens on the upper surface) is of scarcely less than the normal size, besides having a long, black tongue which extends nearly to the cell, while most of the other spots of the same row, on both wings, though much smaller than normal, are decidedly elongated instead of round or quadrate. In the hind wing also, as usually in the normally suffused specimens (if such an expression may be allowed for an aberration), the extra-mesal spots of the under surface are almost altogether obliterated and in the same manner, the median spots being, as there, the most persistent. This form of aberration, where the weakness of the spots has been carried to partial obliteration, is much rarer than the ordinary strigate suffusion.

H. H. FULLIOLA (*Chrysophanus americanus* var. *fulliolus* Hulst. Ent. Amer., II: 182, 1886). In this "the coppery red is replaced by an equally glowing, somewhat sooty yellow," according to Hulst. It is perhaps not different from a specimen captured at Ellsworth, Me., in 1886 by Mr. Carl Braum which is remarkable for having the fiery red of the upper surface uniformly bleached to a pale, but glistening saffron; a faded trace of the original brilliant color is found only on the griseous costal margin of the front wings and at the anal angle of the hind wings. The specimen is tolerably fresh and was captured, according to Mr. Braum, in its present condition. It corresponds in this species to the aberration of *Heodes phlaeas* named *schmidtii*.

Finally an aberration recorded in the Bull. Brookl. ent. soc., II: 8, in which the under surface of the hind wing on the right side is "marked by red dashes running from base to exterior margin."

Egg 65:21. Cells subcircular but angulated, the largest about .19 mm. in diameter, the smaller about .1 mm., excepting next the base, where they are only .045 mm. broad; they are bounded by distinct, heavy, greatly elevated walls, thickened at the junction of several cells; the surface within the cells is shallowly concave and marked by delicate, excessively tortuous lines, covering the whole area and giving it the appearance of frosted glass. Micropyle rosette (68:10) .12 mm. in diameter, made up of little lenticular cells, about .01 mm. in diameter. Color very delicate pale green, the walls of the cells white or hoary. Height, .29 mm.; breadth, .62 mm.

Caterpillar. *First stage* (71:1). Head (79:39) pale testaceous, the sutures of the triangle blackish fuscous; ocelli blackish fuscous; edge of labrum and mouth parts tinged with ferruginous. Body pale yellowish green, with a dark brownish spot on the top of terminal segment; warts, both simple and hair-bearing, blackish fuscous, those of the laterostigmatal series with a pale centre; hairs pale brownish; stigmata testaceous. Legs greenish yellow; claws fuscous; prolegs yellowish. Length, 1.12 mm.; width, .26 mm.; length of superior longest hairs, .5 mm.; of superior shorter hairs, .14 mm.; of lateral hairs, .17 mm.; width of head, .25 mm.

Second stage. In this stage the whole aspect of the creature has changed on a minute inspection. The form becomes less exaggerated in its distinctions between front and hind end, the body is broadest at the second thoracic segment, and instead of the single series of excessively long, spiculiferous hairs, there are now a multitude of series with spiculiferous hairs; but the hairs are not nearly so curving nor so long, and all are of the same length; there are about twenty-five hairs to a segment; besides these the crateriform warts have increased in number, are lower down than before, not all in one row, several on a segment of unequal size and varying from segment to segment, and even apparently at the two sides of the body. The skin is delicately shagreened, and the body is of a pale, pellucid brown color. Spiracles black rimmed. Length, 2.2 mm.; breadth, .5 mm.

Third stage. Head blackish castaneous, antennae pale. Body above and below delicate grass green, slightly darker along the middle of the sides; a faint, dusky, dorsal line. Hairs brownish fuscous, curving backward a little. Spiracles luteo-

fuscous. Legs slightly infuscated, tipped with fuscous; prolegs of the color of the under surface. Length, 3.5 mm.; breadth, 1 mm.; height, .8 mm.

Fourth stage. Head pale yellowish green, edged below, including the bottom of the ocellar field, with blackish fuscous, the suture of the triangle marked with fuscous; labrum rimmed with whitish; mandibles reddish fuscous. Body as previously described; in some instances a dorsal stripe and a broad, ventrostigmatal band around the whole body, dull roseate, the color apparently confined to the hairs. Length, soon after moulting, 5 mm.; breadth, 1.75 mm.; height, 1.35 mm.

Last stage (75:42; 79:40). Resembling the former altogether, excepting that all the specimens with roseate stripe and margin which I have reared become wholly green after the last moult. Length, 14.5 mm.; breadth, 4.25 mm.

Chrysalis (84:49). The general color is light brown or livid, tinged with very pale yellowish green. The thorax is darker and tinged with ferruginous, dotted and spotted with blackish fuscous, a subdorsal pair at the highest point of the mesothorax. There is a rather broad, blackish fuscous, dorsal streak on the mesothorax, and on either side a similar dark band follows the hinder edge of the mesonotum and reaches the base of the wing; the dorsal region of the abdomen is infuscated. The lower surface is paler; the eyes are reddish brown, and the interspaces of the wings are mostly filled with blackish brown streaks darkest toward the upper border. On the abdomen are many rows of roundish black dots arranged in longitudinal series as follows: a faint, dorsal row placed centrally; a faint, subdorsal series placed posteriorly; a laterodorsal series placed anteriorly; a lateral series placed anteriorly; close to it a laterostigmatal series placed posteriorly; a stigmatal series placed posteriorly, further back than the other posterior dots and composed of two confluent dots; an infrastigmatal series placed posteriorly, and on the posterior segments having a companion on the anterior part of the segment; a lateroventral series placed centrally and a double subventral row. Raised lines covering the body russet, the short, fine hairs reddish or blackish; the lower equal portion of the pedicels of the fungiform papillae (86:33) blackish fuscous, the disks colorless. The warts on which the papillae are mounted are .0127 mm. in diameter, the pedicel half that diameter, and the equal portion .047 mm. long; the expanded portion is .025 long and the disk .055 mm. in diameter. Length, 9.5 mm.; height, 3.5 mm.; breadth at thorax, 3.25 mm.; breadth at abdomen, 4.25 mm.

Comparisons. Harris, in some unpublished notes upon this species, which he was really the first to distinguish from *H. phlaeas*, says: "It not only differs from *phlaeas* in the color and more distinct spots of the under side of the under wings, but it exhibits on the upper side of these wings a black, central line and a submarginal series of black spots before the fulvous band much more distinct than do the European specimens of *phlaeas*. The external angles of the anterior wings are more rounded and the emargination near the anal angle of the posterior wings is not so deep, and consequently the anal angle not so pronounced as in *phlaeas* of Europe."

I have not been able to make direct comparisons of the early stages, excepting of the egg. This in *hypophlaeas* agrees entirely in size and proportions with that of *phlaeas*, but the surface is more rugose, the rugosities more connected in tortuous lines, and are also slightly more pronounced in *hypophlaeas* than in *phlaeas*, besides which the cells in our species are slightly smaller and consequently more numerous.

Distribution (25:3). This member of the Alleghanian fauna is widespread, invading the southern portions of the Canadian fauna and extending to the Pacific coast; its very abundance has prevented its specification

in many places, so that our knowledge of its southern limit is not very definite. It is, however, "usually common" in Maryland (Uhler) and is even painted by Abbot with the memorandum, "met with by Mr. Elliott on his tour to the mountains," *i. e.*, the Alleghanies of Georgia; although it occurs in California, and is stated by Saunders to be found in Canada from the Atlantic to the Pacific, it has not been traced across the continent, but only indicated at one or two points west of the Mississippi, such as Oxley Rancho, between Ft. Macleod and Calgary (Geddes), and Iowa (Chic. Mus.); the westernmost points east of this in which it has been obtained are Racine "common" (Hoy) and Beloit, Wisc. (Chamberlin); it is, however, abundant enough in northern Illinois (Worthington), Michigan (Mich. Univ. Mus., Harrington), and at Sault St. Marie (Bethune), and evidently must be connected with California through more northern latitudes. Eastward it occurs in Nova Scotia (Brit. Mus., Jones) and Cape Breton (Thaxter) and in the north has been taken at Cacouna (Saunders), Quebec (Bowles), Montreal "generally common" (Caulfield), River Rouge District (D'Urban), and Ottawa (Billings, Fletcher), and has even been taken at Moose Factory, James Bay (Weir). Of late years what has been credited to this species has been reported as taken in Norway.

It is found throughout New England almost as abundantly in the White Mountain district as elsewhere, and is one of our commonest species.

Haunts. It is found most commonly in dry, sandy or gravelly, barren spots favorable to the growth of sorrel, and is particularly common by the side of paths in dry pastures or upland highways. It constantly invades the town, and, *afire* itself, seems to delight in finding the hottest places for its gambols. Near Quebec Mr. Bowles finds it "in rocky places where there are mossy spots."

Oviposition. When laying her eggs the female flies to a plant of sorrel, remains nearly or quite still, often for two minutes or more, and then walks down the plant, moving this side and that, in search for a suitable spot, until finally, turning entirely around and curving the body downward she deposits a single egg; this occupies about three seconds and then she crawls back and at once takes flight. The eggs are usually laid near the base of the leaf on the rounded surface, but sometimes on the leaf itself indifferently above or below and occasionally on the stem; many eggs may be laid upon a single plant, but I have never found more than one on a leaf in free nature. Five females confined in June over sorrel laid 120 eggs, of which 51 were laid upon the upper surface, 45 on the under surface, 8 on the edge of the leaves and 16 on the stems. They hatch in from six and a half to ten days, according to the season.

Food plants and habits of caterpillar. The caterpillar appears to feed only on the common sorrel (*Rumex acetosella* Linn.) although

several persons, apparently quoting Harris, say that it devours also the dock (*Rumex crispus* L.) and other species of the genus. Harris, however, merely suggests that it may do so. The European phlaeas is also said to feed both upon dock and sorrel, although recently Prittwitz has affirmed that it devours only the latter (*Rumex acetosa*). Mr. Lintner informs me that ours will feed on clover. In making its exit the caterpillar eats only the summit of the egg, where the pits are small and separated by thin walls; usually it feeds upon the under surface of a leaf and while very young eats little holes of about its own size half way through; afterwards it ploughs its way through the parenchyma of either surface, making straight or slightly curving grooves as wide as its own body and several times longer; when still older it devours the leaf at the edge. Just before pupation, the fungiform appendages of the coming pupa appear as white hemispherical papillae dotting the surface of the caterpillar.

Life history. It is double brooded in the northern, triple brooded in the southern parts of its range, changing in New England at about $43^{\circ} 15'$ N. Latitude, but with some variation, or not far north of the dividing line between the Canadian and Alleghanian faunas; throughout Maine, at least as far south as Brunswick, in the White Mountain region of New Hampshire and probably in Williamstown, Mass., it is double brooded; it is triple brooded throughout Massachusetts (excepting perhaps in parts of Berkshire) including the elevated towns of Andover and Princeton, as well as in Albany, N. Y. and Walpole, N. H. We may perhaps add to this list Milford and Dublin, N. H., and Sudbury, Vt., although in the first two localities at least the appearance of the broods is somewhat later than in Massachusetts, the dates agreeing better with those Mr. Saunders has furnished for Ontario, where he believes it to be only double brooded.

In the southern or triple brooded districts the insect makes its appearance from May 10-23 according to the season. Dr. Harris raised one specimen from chrysalis on May 1, but this was probably under artificial conditions. He, however, reports one capture as early as March 15 and Dr. Packard another in Brunswick, Me., April 3,—both of which seem to be altogether exceptional and the result of unusually warm weather acting upon chrysalids in very favorable stations; it becomes common in about a week and continues until about the end of the third week of June. The eggs are laid during June and in advanced seasons during the latter part of May; after six or seven days, or if very early, as much as ten days, these are hatched; the caterpillars become full grown during the latter part of June and early in July and after about ten days spent in the chrysalis evolve a new brood of butterflies. This first appears between July 5 and 10, becomes abundant by the 19th or 20th and continues until after the middle of August, sometimes until almost the end of the

month. The eggs are probably laid during the last week of July and the first half of August, as pairing is then common, the earliest caterpillars become full grown toward the middle of August, while the chrysalids continue for a longer period than in July, sometimes for nineteen days. The third generation of butterflies is much the most abundant and appears in the latter part of August, generally by the 26th, but sometimes not until the early days of September; the butterflies continue to emerge from the chrysalis until the middle of September when the brood is most abundant, but it has generally entirely disappeared by the close of the month. The eggs of this brood are deposited in September, are hatched in eight days, and the larva probably changes to chrysalis before winter. Some of my caterpillars, however, did not reach their last stage until October, and such may possibly hibernate in this condition, or as Mr. P. S. Sprague believed, perish altogether.

Where the butterfly is double brooded, the first generation does not make its appearance until June—usually between the 4th and the 10th, though a few specimens may occasionally be seen in favorable seasons late in May; it becomes common by the 19th or 20th and lasts until nearly the middle of July; in the extreme north, however, as at Quebec and Cacouna, it does not seem to appear before the last of June and probably continues throughout July. The period of the earlier stages is undetermined excepting that the chrysalis generally lives about twelve days, but the second brood of butterflies is first seen between the 6th and 12th of August, and continues to emerge until the close of the month and flies until the end of the third week of September; the eggs are probably laid late in August and early in September*, giving the caterpillar ample time to attain its growth and change to chrysalis before winter; the chrysalis is found hanging upon the under surface of stones.

Habits and flight. The butterfly alights on stones or twigs and suns itself, or flits away among the clover heads. It never flies long distances, nor rises more than a foot or two above the ground, but flutters rapidly from side to side, with a peculiar motion; after each flutter the wings are apparently closed an instant, for during flight their under surface is distinctly visible. It is very pugnacious, attacking and pursuing larger butterflies, and even assaulting the monster Carolina locust (*Dissosteira carolina*) in its short and heavy flight. When two of the *Heodes* meet, they circle rapidly and coquettishly about each other, always keeping near the ground. In keeping with its activity is the fact that it is one of the first butterflies to appear after sunrise, and one of the latest to disappear at nightfall. It is on its unceasing rounds the livelong day.

* Gosse writing from Compton, Canada, laid nine eggs; they were "...flesh-colored." says that in September "one that I had taken (Can. nat., 221.)

Gosse, in writing of this insect, says (Can. nat., 219) it

would be perhaps the most splendid butterfly we have, if its size corresponded with its beauty. . . . The richness of the glowing, flame-coloured wings is worthy of admiration, and the under surface is very delicate; and I do not see that it is less beautiful because it is diminutive; though if it were as large as a swallow-tail or a Camberwell beauty, it would strike the attention more readily.

It is curious to watch their proceedings in pairing time, which remind one strongly of the English sparrows. One may be seen perched on a leaf, its hind wings quite still and horizontal, while the front pair are slightly raised and in a constant flutter. Its follower will be close behind it, apparently unconcerned, but as it walks after the leader, the latter walks off a little further; the little play will proceed a while when the leader flies away, quickly followed by the other. Which sex takes the lead in this performance I have not determined.

Postures and sleep. These butterflies are very fond of resting on bare spots fully exposed to the sun; wherever they alight, even if on a twig, they at once turn around so as to bring their back to the sun, and open their wings at right angles, the fore wings partially concealed by the hind pair; the antennae diverging at an angle of from 95° – 100° . When resting in the shade, the wings are closely appressed, the fore wings concealed by the hind pair, so that the costal edges are brought together; the antennae, viewed from above, are perfectly straight, and spread at an angle of 85° , their tips being about 11 mm. apart; when viewed from the side they are slightly curved downward, but otherwise are straight and nearly continuous with the body. When walking, even on a perpendicular surface, the tip of the abdomen is trailed on the ground and the fore legs are used like the others.

When they emerge from the chrysalis they at once seek a vertical surface to expand their wings, which then hang, when fully expanded, so that the costal edges of all the wings are together, and the inner edge of the hind wings just touch the surface of rest; the antennae are then held quite horizontally (or later are slightly raised), and are scarcely parted, the clubs often in actual contact.

Miss Caroline G. Soule, observing this butterfly clinging, toward sunset, to grass blades, with drooping wings, made some experiments to see how soundly it slept (Psyche, v: 42):—

Approaching one. I gently touched the grass, but the butterfly remained as before. I shook the grass. ~~then~~ shook it less gently, but the butterfly did not stir. Then I plucked the blade and carried it in my hand, not taking any care to keep it upright, for five blocks [in the city], and even then it was only as the sun struck the grass, when I crossed the street, that the butterfly awoke, and lazily flew to a shady place, resting as before. I followed, and this time a touch was enough to startle it. I did not arouse it a third time, but afterwards, in the country, I tried the same experiment several times, always with the same result.

I have always found the butterfly in the same position, more than half way up the

grass blade, in the shade, and with the head up, the wings drooped to an acute, instead of a right angle with the body. It certainly sleeps very soundly, and when aroused does not become so active as in the middle of the day.

I have waked and disturbed one... six times, each time immediately after it had settled down after a former awakening, and even the last time it flew but ten steps or so, and settled down as before.

I once counted seven perched for the night on grass blades, within an area of four square feet. I have generally found them on buffalo or herd's grass, about half way down the stalk, but with the head *downward*, the costal edges of both wings together, the abdomen bent back at an angle of 135° with the thorax, the antennae straight forward, parted at an angle of about 15° .

Dimorphism. According to Pryer, *H. phlaeas* is very strongly affected by temperature; the first brood, which appears in Japan in March, is very brightly colored; while the later summer broods are much darker and the male almost black. Zeller makes a similar statement concerning Sicilian specimens, though in Switzerland, according to Meyer Dür, the differences are not nearly so great. In *H. americana*, also, we find such differences, but whether they vary in the north and south I do not know. Specimens of the spring brood in Massachusetts are of a more fiery red, and the orange band of the under surface of the hind wings is broader; while in the later broods the markings are less vivid and less distinctly marked, and there is a longer tooth on the margin of the hind wings.

Miscellaneous. Mr. Gosse records (*Can. nat.*, 220) a curious instance of possible hermaphroditism in this insect. He says: "There is often considerable diversity in the vividness of colour of different individuals of the same species of butterfly or moth, one being much more beautiful than another; in the same individual, however, one wing in general exactly corresponds with the other, its fellow. But I once took a small copper in the month of September, which had a very apparent difference in the colour of the wings, the left fore wing being much lighter on both surfaces than the right, though neither was defaced in any degree. It was resting on a stalk of grass, and was unwilling to fly, the weather being cold with misty rain."

Dimmock states that the butterfly is an important agent in the fertilization of the dandelion.

Enemies. This insect is subject to at least two hymenopterous parasites. Expecting that so common a species would have its enemies, I collected a large number of eggs, laid naturally, at Norwich, Conn., in June, but only one of them had been attacked; the little parasite, *Telenomus graptæ* (89:9) ate its way out through the bottom of one of the cells on the side, on June 23. Another parasite is *Ichneumon versabilis* (88:2), a much larger insect, which attacks the caterpillar and emerges from the chrysalis; one came out fifteen days after pupation. Gentry asserts that

it is also destroyed by the wood pewee (*Contopus virens*) and the night hawk (*Chordeiles virginianus*), as he has taken large numbers both of the larva and imago from their stomachs.

Desiderata. Although so common an insect, our knowledge of its history is far from perfect. The two or three records of its excessively early appearance remain unexplained. We do not know whether it ever hibernates in the larval condition, and if it does whether such hibernation is confined to localities where it is triple brooded; the line of demarcation between the double and triple brooded stations needs to be carefully traced, and this limit will most probably be of considerable importance for lepidopterological life in general; western Massachusetts, the southern half of New Hampshire and Vermont and Maine, south of Portland, should be especially studied. The duration of the egg and chrysalis for each brood needs to be established by abundant observations in the north and south. Doubtless other parasites may be found.

LIST OF ILLUSTRATIONS.—*HEODES HYPOPHLAES*.

General.

- Pl. 25, fig. 3. Distribution in North America.
88: 2. *Telenomus versabilis*, a parasite.
89: 9. *Telenomus graptae*, a parasite.

Egg.

- Pl. 65, fig. 21. Plain.
68: 10. Micropyle.

Caterpillar.

- Pl. 71, fig. 1. Caterpillar at birth.
75: 42. Full grown caterpillar, dorsal view.
79: 39, 40. Head, stages I, V.

Chrysalis.

- Pl. 84, fig. 49. Side view.
86: 33. Dermal appendage.

Imago.

- Pl. 5, fig. 11. Male, both surfaces.
13: 5. Both surfaces.
34: 38. Male abdominal appendages.
39: 21. Neuration.
55: 10. Side view with head and appendages enlarged, and details of the structure of the legs.

FENISECA GROTE.

Feniseca Grote, Trans. Am. ent. soc., II: 308 (1869). Type.—*Hesperia tarquintus* Fabr.

His cloak, of a thousand mingled dyes,
Was formed of the wings of butterflies.

DRAKE.—*The Culprit Fay*.

Soon spreads the dismal shade
Of mystery over his head;
And the caterpillar and fly
Feed on the mystery.

WM. BLAKE.—*The Human Abstract*.

Imago (55: 11). Head moderately large, densely clothed with scales and profusely covered with rather short curving hairs, bending forward above and downward on the face. Front flat, excepting that it is very slightly full down the middle and a very little protuberant below, the lower half projecting slightly beyond the front of the eyes; half as high again as broad, scarcely as broad as the eyes on a front view, the sides straight; upper border scarcely ridged, the corners a little hollowed in front of the antennae; lower border very broadly rounded. Vertex slightly hollowed in the very centre, with a slight sulcation running from the middle of the hinder border to each antenna and a rather abrupt, not very large, tuberculate bump behind each antenna; separated from the occiput by a rather large and deep, slightly zigzag chan-

nel. Eyes of moderate size, pretty full, naked. Antennae inserted with their hinder border in the middle of the summit, separated from each other by a space equal to twice the diameter of the second antennal joint; of the length of the abdomen, composed of thirty joints of which from eleven to thirteen form a gradually increasing club, the limits of which are a little indefinite; it is cylindrical, scarcely depressed, twice as broad as the stalk, equal for most of its length, five or six times as long as broad, the tip bluntly conical, two joints only entering into the diminution of size. Palpi very slender, about half as long again as the eye, the last joint more than half as long as the penultimate, and clothed only with recumbent scales, while those of the other joints are very abundant, rather long and projecting, although destitute of any long fringe of hairs and scales.

Patagia long and slender, arched a little and slightly tumid, more than three times as long as broad, the basal two-thirds tapering, the apical third equal one-third as broad as the base, the tip blunt; inner margin of the whole straight.

Fore wings (39:24) two-thirds as long again as broad, the costal margin slightly and regularly convex, the angle abrupt, rectangular, the outer margin roundly bent a little just below the middle, the two portions nearly straight, the inner margin straight, the angle rounded off. Costal nervure terminating on the margin opposite the extremity of the cell; subcostal nervure with three superior branches, the first arising just before the middle of the outer two-thirds of the upper margin of the cell; the second about midway between the origin of the first and the tip of the cell; the third as far beyond the apex of the cell as the second before it, forking rather before its middle; the main subcostal branch scarcely bent upward between the apex of the cell and the base of the third branch; veins closing the cell transverse, independently arcuate, distinct only in the third of each next the main veins. Cell half as long as the wing and four times as long as broad.

Hind wings with the costal margin somewhat convex on the basal third, beyond straight, the outer margin with the upper half strongly rounded, the lower half slightly convex and continuous with the upper half, the border produced considerably just above the middle and particularly in the ♂; inner margin gently convex, the angle broadly rounded off. Submedian nervure terminating at the anal angle; internal nervure terminating in the middle of the outer half of the inner margin.

No androconia.

Fore tibiae about five-sixths the length of the hind tibiae (♀), or scarcely shorter than they (♂), the tarsi scarcely shorter than the tibiae, particularly in the female; forelegs similarly developed in the two sexes, excepting that the last tarsal joint of the male is only armed with a median, apical, slightly curving, rather stout and tapering spine, instead of agreeing in structure with the other legs as in the female; in other respects, and with perhaps the exception of having rather fewer spines beneath, these legs agree with the others. Femora furnished beneath with a fringe of long hairs. Middle tibiae scarcely shorter than the hind pair, both entirely devoid of spurs and spines. First joint of the middle and hind tarsi considerably gibbous in the male; in the other sex and in the fore legs of both it is of the same diameter as the other joints, nearly or quite equal to all the others combined; the second, third and fourth are equal and the fifth rather longer than the third and fourth together; joints armed beneath rather feebly with short and rather slender spines not crowded together nor present on the sides, an apical pair on each joint scarcely longer than the others, the whole under surface scaled; claws very small and slender, not curving much but somewhat bent near the base, tapering, finely pointed; paronychii single, quite slender, equal, finely pointed, fully as long as the claw, and straight; pad scarcely perceptible.

Male abdominal appendages with the upper organ forming a deeply and not very narrowly but abruptly notched hood projecting above; lateral arms much as in *Chrysomimus*. Clasp stout but very short, bulate at base, abruptly narrowing to half the width on apical third.

Egg. Very oblate spheroidal in shape, about twice as broad as high, the summit

with a central, shallow and small indentation. Cells very numerous and with slight walls.

Caterpillar at birth. Head as broad as the first thoracic segment, broadest above the middle, rather deeply and broadly cleft in the middle above, the triangle large, just failing to reach the cleft, higher than broad. The posterior structure of the head is as in all Lycaeninae, rendering it capable of being enfolded in the membrane intervening between the cranium and the first thoracic segment. Body cylindrical; first and last segments a little smaller than the others, both with a central chitinous shield, the former transverse with a sinuate anterior margin, the latter triangular, the apex backward and the sides convex. Legs and prolegs well developed, the hooklets of the latter only five in number but very long, longer than the leg claws and falciform. Spiracles greatly elevated on truncated cones, that of eighth abdominal segment on a level with the others. The papillae are of various sizes and numerous and bear long, curving, tapering, delicate and spiculiferous hairs, those of the thoracic segments generally directed forward, those of the abdominal backward. There is a subdorsal series of small papillae posteriorly situated on the 2-3 thoracic and 1-8 abdominal segments, a central laterodorsal series on 2-3 thoracic and 1-9 abdominal segments, small on the thoracic, large on the abdominal; a lateral series large and central on 2-3 thoracic, of medium size and posterior on 1-8 abdominal segments; an infra-lateral series, minute and posterior on 1-8 abdominal segments; a suprastigmatal series, large and central from 1st thoracic to 8th abdominal segments; and on each side below the spiracles, apparently two pairs, a longer and a shorter in each, anteriorly and posteriorly placed on each abdominal segment. Besides these there is a posterior infra-lateral annulus on the third thoracic segment, and a lateral central series of annuli on the 1-8 abdominal segments; also many hairs situated on papillae arranged in a transverse row on the first thoracic and an arcuate row on last abdominal segment. The position, central or posterior, of all the body papillae places them on each segment in a double, transverse series.

Mature caterpillar. Head moderately large, rounded, subquadrate, the cranium nearly twice as broad as high and nearly as deep as high, only half withdrawn within the first segment when at rest. Frontal triangle very large, occupying nearly one-third of the front view of the head, equiangular; labrum large, arched and very thick, slightly and roundly emarginate in the middle, the outer angles well rounded; antennae with second joint slender, cylindrical, a little more than twice as long as broad with a not much longer bristle; mandibles small, concealed completely in the mouth cavity, scarcely longer than broad, scarcely tapering, the rounded apical margin armed with four curving, claw-like teeth; maxillary palpi larger than usual, composed of three joints decreasing regularly in size so as to form a conical, movable, pointed appendage, very similar in appearance to the legs.

Body largest in the middle and tapering toward either end, both as seen from the top and sides, the incisures deep and their moniliform effect on the body intensified by the irregularity of surface of the segments, which are tumid in large and broad bosses on the lateral, suprastigmatal and infrastigmatal lines, giving a subquadrate cross section, which is increased by the flatness of the dorsal area. Furnished abundantly with scarcely arcuate, tapering, finely spiculiferous and pointed hairs, about as long as the segments of the body, and arranged irregularly in a comparatively broad field transversely across the summit of each segment, but clustered most abundantly on all but the first thoracic segment on the elevated bosses. Terminal segments without special appendages, the last with a central anterior sunken pit. Spiracles minute, transversely oval, scarcely elevated, that of eighth abdominal segment on a line with the others. Legs small, the last joint slender, compressed, tapering. Prolegs minute, not visible either at rest or in movement.

Chrysalis. Viewed from above the head is truncate with rounded lateral angles, the thorax rapidly widening to the middle and then nearly equal, though beginning posteriorly to widen by the divergent outline of the wings as they expand toward the widest part of the abdomen; the latter globose basally, including five segments, the great-

est width being reached in the middle of the third segment, and nearly maintained to the middle of the next, and then rapidly falling off with a regular slope to the end of the seventh segment; beyond this the abdomen expands again slightly, the final segments forming a curious flaring expansion which rests flat upon the surface of pupation and beneath which the equally flattened cremaster is hidden, with its subrecumbent hooks. Viewed laterally, the curve of the thorax forms the quadrant of a circle, the front rising rapidly, the whole thorax bluntly carinate mesially; considerably above this rises the globose portion of the abdomen with independently arched segments, its posterior curve continued in a straight slope to the tip. The basal wing tubercles are rather prominent but broadly rounded and slightly tuberculate, an interrupted, blunt carina follows the middle line of the abdomen, and the dorsum of the second, third and to a less extent the fourth abdominal segments has a transverse, mesial series of blunt and small tubercles. The under surface is perfectly flat and smooth. The girth falls in the incision between the first and second abdominal segments. The tongue cases are exposed only a little more than half way from their base to the tip of the wings.

Distribution and characteristics. This strictly American genus contains but a single species, which has a greater latitudinal distribution than any other of our *Chrysophanidi*, as will be seen under the species. The genus differs more from our other *Chrysophanidi* than they differ among themselves, whether in the structure or markings of the imago or in the characters of the earlier stages. Indeed its affinities are with some Indian forms and it bears a certain curious resemblance to the butterfly from northern China, first described by Bremer-Gray under the name of *Thecla fusca*; I have been unable to make any examination of the latter. The butterflies are among the largest of the tribe and the wings are unusually delicate in structure, more elongate than common and subquadrate in form. The ground color of the upper surface may be considered fulvous although so largely encroached upon by dark brown in the upper half of both wings and the outer border of the front pair as to be scarcely predominant; in the fore wing the dark borders leave only the bright disc and this is nearly divided transversely; beneath, the wings are pale reddish brown, the forewings pale on the disc, and both wings, especially the hinder pair, mottled with pretty large, white edged, dark spots, which on the hind wings are arranged in transverse series.

The butterflies are polygoneutic, hibernating in the chrysalis and perhaps in the imago state. They first appear on the wing very early in spring. They are very local, being found only in wet and shady places.

The eggs are remarkable for the great number of the cells which cover the surface and the slowness of their bounding walls; they are flattened spheroidal in shape and are laid upon twigs in the immediate neighborhood of plant-lice.

The carnivorous caterpillar. For the most interesting feature about the insect is the carnivorous character of the caterpillar, which feeds exclusively upon plant-lice and appears to choose those which congregate in masses and exude a cottony secretion. It is interesting in this connection

that so far as I recall it is only in Lycaenidae that we find other instances of a carnivorous tendency, as in *Cyaniris pseudargiolus*, *Everes amyntula* and *Thecla acadica*, where the caterpillar sometimes devours its neighbors. It has also been plausibly suggested by Dr. Holland that *Liphyra*, an Indian genus of Lycaeninae, may have an exactly similar habit to *Feniseca*. The structure of the caterpillar of *Feniseca* bears witness to this anomalous habit, departing in many points widely from its neighbors. At birth, it is slender and cylindrical, the head as broad as the body; the latter is covered with serial hairs and lenticles. The mature caterpillar is in general similar to its allies in shape, but is remarkable for its delicate skin, transverse head with enormous frontal triangle, the small size of the first thoracic segment, the partial fasciation of the very long hairs which clothe the body and the rather large size of the prolegs. It is further of special interest from the modification its mouth parts have undergone to adapt them to its strange carnivorous diet. The mandibles are very small, quite concealed by the projection of the parts around and armed with four very sharp, claw-like teeth, while the maxillary palpi have assumed the tapering form of the larval leg, by which they are probably enabled to seize an aphid and draw it within reach of the mandibles. In addition, the thick and arched labrum and plump labium form with the base of the maxillary palpi a sort of short tube for the passage of the fluids of the victim; whether any special pharyngeal appliances aid in sucking up the juices I have not attempted to investigate.

The odd chrysalis. The chrysalis is an odd looking object and the anterior half with its bizarre markings bears, when viewed laterally head downward, a curious resemblance to a monkey's face, as pointed out by Miss Morton. It is far more irregular in surface and form than any other of our *Chrysophanidi*, the abdomen being basally hunched and laterally expanded, and the segments provided with transverse series of low tubercles; besides which the last segment with the preceding form a separately curved, transverse, subspatulate pad for the cremastral hooks.

The position of the genus. Mr. W. H. Edwards indeed is so much impressed with the strangeness of the early stages that he declares, but without giving the slightest reason for his opinion, that it belongs to the *Lemoniinae*. He emphasizes only such features as strike him as departures from the *Lycaeninae*. Unfortunately his comparisons were made with the *Lycaenidi* and not with the *Chrysophanidi*. Although certainly an anomalous form, as one would expect in a creature departing so strangely from the others in habits of life incident to a decided change of food, its affinities are all with the *Lycaeninae*, and particularly with the *Chrysophanidi*; and since the features in which it is anomalous do not (except in a single instance, not mentioned by Edwards) ally it any more strongly with other groups, the most that could be done to mark its errant nature would be to consider it a tribe of *Lycaeninae* distinct from, but adjoining the *Chry-*

sophanidi; even this, however, seems hardly warranted. The larva of *Tomares ballus* of southern Europe, which certainly must be classed with the *Chrysophanidi*, departs in many points more strongly from the normal form than is the case with *Feniseca*. The relation of the head to the first thoracic segment and the degree of retractibility of the former within the latter is very much the same. The chitinous shield of the first thoracic segment is the same. The form of the body is far more cylindrical, quite as moniliform, and the prolegs and legs are much more fully developed than in *Feniseca*. The elevation of the segments of the body into bristly bosses in *Feniseca* is intensified and more specialized in *Tomares*, and the sole point wherein the latter agrees better with the normal form is the high position of the spiracles of the eighth abdominal segment; for here, in their alignment with the other spiracles, *Feniseca* is truly anomalous, though according to Guenée the same is the case with *Lycæna bœtica*. *Tomares*, too, possesses the transverse slit of the dorsum of the seventh and the lateral caruncles of the eighth abdominal segment, so common among *Lycæninae*, while *Feniseca*, like *Heodes*, possesses neither. As to the caterpillar at birth there is nothing to distinguish it from other *Chrysophanidi* except the more cylindrical form. Mr. Edwards, to judge from his comments, does not seem to be aware that in all of them (so far as known) the head is of the average body width, but one would suppose that he would be familiar with the young larva of *Heodes*.

I have mentioned the mature caterpillar particularly, as it is upon this that Mr. Edwards specially dwells, and we know very little about the range of variation in the egg and young caterpillar in *Chrysophanidi*. In the former, however, the difference is nearly as great between *Heodes* and *Chrysophanus* as between *Epidemia* and *Feniseca*, and we have no warrant from its structure to exclude the egg of *Feniseca* from the *Chrysophanidi*. Easily the same may be said of the chrysalis, which differs only in generic features from *Heodes*, *Tomares* and the others, and indeed shows its affinity with them in every tribal characteristic, not even departing from them in the fungiform character of its dermal appendages.

EXCURSUS XXXIX.—PERIODICITY IN THE APPEARANCE OF BUTTERFLIES.

Au printemps de nos jours, notre âme à peine éclosée,
Volt ainsi l'avenir rayonnant de bonheur,
Et sur un doux espoir sans crainte se repose,
Comme le papillon sur le sein d'une fleur.

DIDIER.—*Le Mois de Mai.*

EVERY year we read in the pages of our entomological journals something about the rarity or abundance of this or that insect. Particularly is this the case with those insects which are agricultural scourges, since here the observation of their comparative abundance or scarcity is quickened.

It is none the less true, however, of other insects and among them of butterflies. Indeed there are comparatively few butterflies which appear in similar numbers every year. There is always more or less fluctuation in this regard, but we notice it only when their excessive abundance, especially with such swarming butterflies as *Anosia plexippus* and *Vanessa cardui*, or their great rarity causes general comment, at least among entomologists. Sometimes we can directly tell the cause of a scarcity, rarely that of a superabundance; for in the former case, the scarcity may involve several species, and the plain cause some excessive or exceptional meteorological condition.

Now though the massive meteorological conditions which we term climate have undoubtedly very much to do with the distribution of butterflies and determine, indeed, in very many cases, whether or not a given kind shall or shall not live in a certain place, the indirect results of meteorological conditions have undoubtedly more to do with the abundance or scarcity of a given butterfly in a given season. For the very existence of the butterfly shows its capability of withstanding the excesses of meteorological conditions in the spot in which it lives, and the greatest stresses under which it lives are those more active forces, like insectivorous creatures and parasites, which find their own life dependent on taking its, or its neighbors. The activity of these is governed largely by temperature and storm conditions and hence the indirect influence of meteorological conditions on the life of the butterfly may be more important than the direct. A caterpillar which could withstand any amount of cold or of warmth in itself considered might not be able to battle against the foes which a mild winter kept in unusual activity and need of sustenance. It does not appear that our butterflies suffer particularly from an exceptionally cold or long winter, but rather from unusual warmth, sufficient to arouse insects from torpor at times when hibernation should be expected; or, in the fair season, directly from long continued storms and moisture.

The fluctuation therefore in the numbers of our butterflies is probably due in large measure to the activity or inactivity, the abundance or rarity of their active enemies, and especially, considering how extensive their depredations, to the abundance or otherwise of their parasites. It is the striking of the balance which exists between a creature and its enemies in the struggle of each for its own existence. Let some event, untoward to it, decrease the ratio of the parasite,—the butterfly flourishes; but its very consequent superabundance the following year only gives a better pasturing ground to the parasite, reduces the butterfly below the normal, and causes the parasite to abound inordinately, only to find its food supply cut off by its own voracity and incontinence and the scales again to be turned. It is then this perpetual warfare, this unending, inexorable struggle for existence, testing the fitness to survive, which is the prime cause of periodicity in the abundance of a given species.

FENISECA TARQUINIUS.—The wanderer.

[Little orange butterfly (Abbot); the wanderer (Grote); the plebald (Scudder); brown mottled butterfly (Maynard).]

- Hesperia tarquinius* Fabr., Ent. syst., iii: 319 (1793).
Erycina tarquinius God., Encycl. méth., ix: 556, 580 (1819); —Westw., Don., Ins. Ind., 66, pl. 44, fig. 1 (1842).
Papilio tarquinius Abb., Draw. ins. Gn., Brit. Mus., vi: 87, fig. 170-172; xvi: 35, tab. 80; Gray coll. Bost. soc. nat. hist., 55 (ca. 1800).
Polyommatus tarquinius Boisdu-Lac., Lép. Amér. sept., 128-129 (1833); —Westw.-Hewits., Gen. diurn. Lep., ii, pl. 77, fig. 8 (1851).
Chrysophanus tarquinius Westw.-Hewits., Gen. diurn. Lep., ii: 490 (1852); —Lucas, Sagra, Hist. nat. de Cuba, 616-617 (1857).
Fenisea tarquinius Grote, Trans. Amer. ent. soc., ii: 308 (1869); —Fern., Butt. Me., 87-88 (1884); —Riley, Am. nat., xx: 556-557 (1886); Science, vii: 304 (1886); Can. ent., xviii: 191-193 (1886); —Edw., Can. ent., xviii: 141-153 (1896); —Haley, Ibid., 193-194 (1886); —French, Butt. east. U. S., 279-280 (1886); —Mayn., Butt. N. E., 42, pl. 5, figs. 54, 54a (1886).
Thestor tarquinius Butt., Cat. Fabr. Lep., 174-175 (1860).
Lycæna tarquinius Klrh., Syn. cat. Lep., 345 (1871).
Polyommatus crataegii Boisdu-Lac., Lép. Amér. sept., pl. 57, figs. 1-5 (1833); —Morr., Syn. Lep. N. Amer., 85 (1862).
Polyommatus porsenna Scudd., Proc. Ess. inst., iii: 163-164 (1863).
Fenisea porsenna Grote, Trans. Amer. ent. soc., ii: 307-308 (1869).
Lycæna porsenna Klrh., Syn. cat. Lep., 345 (1871).
 Figured by Glover, Ill. N. A. Lep., pl. 23, fig. 11; pl. 29, fig. 7; pl. 38, fig. 4; pl. B, fig. 5, med.

The Butterfly is with the Rose in love,
 Around her flutters all day,
 But round himself, with tender gold,
 The fluttering, loving Sunbeam's play.
 Yet, with whom is the Rose in love?
 That I'd know too gladly—Ah!
 Is it the singing Nightingale?
 Is it the silent Evening-star?
 I know not with whom the Rose is in love;
 But I love you all: the pale
 Sad Rose, the Sunbeam, the Butterfly,
 Evening-star and Nightingale.

W. P. A.—After Helio.

I am that merry wanderer.

SHAKESPEARE.—*Midsummer-Night's Dream*.

Imago (5:8). Head having a circlet of pure white around the eyes, excepting at the base of the antennae and an equal space behind them; it is narrow in front, extends still more narrowly along the inner side of the base of the antennae and is connected on the lower portion of the front by a broad white belt; behind the eye it is much broader, narrowing upwards and backed by mingled blackish and fulvous scales; above, the head is rimmed posteriorly with fulvous scales, the space just behind the antennae is black and that between them—the summit, together with the front—is filled with mingled fulvous and blackish brown hairs, the former predominating above, the latter below. Palpi, excepting the apical joint, white, the upper surface of the middle joint blackish brown, expanding apically so as to include the upper apical portion of the sides and sometimes nearly or quite the whole of the extreme apex; fringe of lower surface white with a very few black scales mingled at the tip; terminal joint blackish brown, with the extreme tip, and a line along the under side, white. Antennae black, the joints of the stem rather broadly annulated at their bases with white, interrupted, at the middle of both the upper and under surface, over the basal half of the antennae, and suffused so as to occupy nearly the whole of the under surface on the apical third of the antennae; club black, the base more or less touched with white, the apical two or three joints dull luteo-fulvous. Tongue very pale luteous.

Thorax covered above with brownish fulvous, olivaceous and dusky hairs, the patagia mostly with fulvous and reddish fulvous ones; beneath covered with profuse, delicate, white hairs. Femora pearly white; tibiae and tarsi dull, scarcely dingy white, with a blackish brown spot at the base and near the tip of the upper surface of all the tarsi and at the middle of the same on the middle and hind tibiae, as well as on the middle half of the basal tarsal joints and the basal half of the other joints. Spines luteous, claws dark reddish luteous.

Wings above rather pale yellowish fulvous, marked heavily with very dark, rather rich brown, varying greatly in the extent of encroachment on the fulvous tints; in the lightest colored individuals, not correlated with sex, the darker markings of the *fore wings* consist of a narrow fuscous edging to the costal border, faintly interrupted at the nervule tips with fulvous, a broad dash of blackish brown extending to a little beyond the tip of the cell and occupying the whole of it excepting a narrow strip along the posterior portion, generally limited above by a sinuous line and not reaching the tip of the cell; a club shaped streak in the middle of the lower two-thirds of the broad medio-submedian interspace, extending from the base of the wing to below the first divarication of the median, where the club is roundish, a minute patch occupying the very base of the upper median interspace and sometimes connected with the spot in the cell, an irregular roundish spot in the lower median interspace, nearly as broad as the interspace and having its outer limit in the middle of the same; a narrow bordering to the outer margin—a little more than equal to the width of half an interspace, broadening a little in the medio-submedian interspace, extending narrowly along the inner margin half way or more to the base and connected at the upper extremity with a large patch depending from the costal border, broader than long, narrowing to a bluntly rounded tip which reaches the middle of the subcosto-median interspace, its interior border nearly straight and at nearly right angles to the costal margin. On the *hind wings*, the basal half is blackish, fuscous next the extreme base and the outer half fulvous, separated by a line which runs from the hinder border along the middle subcostal nervule half way to the latter divarication of the median, then crosses to, but not over, the lower subcostal, follows that as far as the same divarication, to which it then crosses and passes in a nearly straight course, but mostly hidden by the infuscated surface and the fulvous hairs, to the inner border; a small spot of black is found in the fulvous area in the subcosto-median interspace, next the angle made by the outline of the blackish basal color; and small, roundish, submarginal spots occur in the lower median and medio-submedian interspaces.

In the darkest individuals the blackish color prevails on the *fore wings*, leaving only an extremely irregular, central patch of fulvous, formed of two irregular patches connected by a narrow neck next the base of the middle subcostal nervule; the basal patch is limited above by a straight or sinuous line running along the middle of the lower half of the cell almost to its tip, sometimes nearly enclosing the median nervule, then passing downward in a slightly irregular course with a general direction toward a point a little beyond the middle of the submedian nervule, where it turns inwards and almost immediately upwards towards, but not quite to, the basal bifurcation of the median nervule, curves over inward and then downward to the middle of the medio-submedian interspace and then runs in a straight line to the base; that is, the spots in the median interspaces connect with the dark markings of the inner border, and the other dark markings enlarging leave this irregular patch in their midst; the apical patch occupies the basal three-fifths, excepting the extreme base, of the upper median nervule and a square patch extending upward over two interspaces at the basal half of its upper border; generally there is a slight prolongation downward upon the lower median interspace near its outer extremity. On the *hind wings* there is a submarginal row of dark roundish spots, farthest from the border and largest in the median and medio-submedian interspaces, smaller and almost resting upon the border in those above; in the darkest specimens these coalesce to a greater or less degree and sometimes form a broken, submarginal band, the inner border the larger spots reaching inwards to fully the width of one and one-half interspace from

the margin, leaving, however, a slender thread of fulvous between them and the dusky limit of the outer border, at least in the lower half of the wing; next the inner limit of the fulvous area, as before described, small, brownish spots make their appearance in the lower median and medio-submedian interspaces, which in the darkest specimens become merged in the dark, inner area, so that finally the fulvous area becomes nearly limited to a transversely oblong obovate patch, extending from the middle of the lower subcostal to the middle of the medio-submedian interspaces and occupying the middle half of the apical three-fifths of the wing.

Every gradation between these two extremes occurs and can be found in a comparatively limited series of specimens and are present equally in the most northern and southern localities. In all, the costal edge of the fore wings is dull fulvous, the apices of the subcostal nervules impinging on the costal border are usually fulvous, the narrow fringe is brownish fuscous on its basal half, whitish on the apical half, abruptly interrupted with brownish fuscous at the nervure tips, narrowly on the upper, very broadly, sometimes almost to the extinction of the white, excepting in the medio-submedian interspace, on the lower half. Fringe of hind wings varying from dirty white to grayish fuscous, tinged on the basal half with dull fulvous, interrupted at the nervure tips rather broadly with blackish fuscous.

Beneath: *fore wings* dull, very pale orange, the basal half and apex of the costal border, the whole outer border, but especially above, broadly bordered with deep, dark yellowish brown; in the middle of the cell, at a little more than one-third and two-thirds distance from the base are two darker, often fuscous spots, narrowly rimmed with whitish; the club-shaped spot of the upper surface is reproduced below in fuscous, the basal half expanding to the median nervule with its centre; at the tip of the cell is a pretty large, transverse, oval or quadrate spot, of dark yellowish brown, edged narrowly within and without with whitish; directly below it, in the lower median and medio-submedian interspaces, are two large, fuscous spots, the upper generally longitudinally quadrate, filling the width of the interspace, the lower sometimes obsolete, always smaller than the upper, variable in shape, usually with an excision from the lower inner corner; occasionally there is a roundish, dot-like spot at the base of the upper median interspace; a broad, subapical, transverse, nearly equal, but a little irregular and slightly curving band of dark yellowish brown passes from the costal margin to the upper median nervule, its interior sinuous border narrowly edged with white, distant from the spot at tip of cell by a little more than its own width, its outer border usually edged obscurely, as far as the last subcostal nervule, with whitish, followed immediately by white-edged, yellowish brown lunules, sometimes obsolete, and next the upper half of the band a dull, hoary, grayish patch extending half way to the outer border, and enclosing at its outer limit, in the next to the lowest subcostal interspace, a minute, round, yellowish brown spot, annulate with whitish; in the lower median and medio-submedian interspaces, or only in the latter, are similar, slightly larger spots, at a similar distance from the margin. Fringe much as above. *Hind wings* deep, dark yellowish brown, the basal half, and often to some extent the whole wing, glossed with a grayish bloom, excepting in frequent, pretty large, roundish spots, encircled with white; there are two transverse, curving rows of these spots within the middle of the wing, each having one spot in the costo-subcostal interspace, the cell and the medio-submedian interspace, the fourth spot of the inner row being in the internal, that of the outer in the submedio-internal interspace; the outer row crosses the basal divarication of the median, and the inner is midway between it and the base; across the middle of the wing is a broad belt of these spots, to a great degree confluent and confused, broadest and deepest in tint on the upper half of the wing, its outer limit marked by a series of strongly curved, whitish lines, one in each interspace, having a general, slightly curved direction, its convexity inward below the middle of the subcosto-median interspace, above it subparallel to the outer border; on the outer half of the wing the yellowish brown is infuscated above the middle subcostal nervule, but at the extreme upper outer angle, beyond the limit of the mesial band, a small, sometimes obsolete, hoary grayish

patch; a submarginal series of small, white, round annulations, the space within somewhat darker than the outside, one in each interspace, that in the medio-submedian double, smallest in the middle of the wing, and increasing gradually in size toward either border; a slender thread of yellowish brown edges the hind border. Fringe much as above, excepting that the extreme base has a faint, pale thread.

Abdomen above and on the sides blackish brown, below white; the appendages of the male (34:35) with the upper organ triangular as viewed from the side, the dorsal portion much produced and notched, with equal sides, half way to the base; lateral arms very slender, aciculate, roundly bent before the middle, delicately tapering and a little upcurved at the tip. Intromittent organ equal, obliquely truncate at tip. Clasps moderately stout, about two-thirds as long as the upper organ, the basal buliate portion slightly longer than broad, the apical third half as broad as the basal, turned inward a little at tip, the upper angle rectangular, the lower well rounded.

Measurements in millimetres. Length of tongue, 2.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	11.3	16.2	18.	16.5	16.5	17.5
antennae.....	8.	6.25	7.4	9.	6.	6.5
hind tibiae and tarsi..	2.6	3.75	3.9	3.5	3.5	3.75
fore tibiae and tarsi..	2.	3.	3.2	3.	3.	3.2

Egg (65:24). Faint green, almost colorless, glistening; surface smooth and glistening, though still very faintly punctulate, broken up by very slight, slender and equal, rounded elevations into polygonal cells whose height is a little greater than their breadth, being about .06 X .08 mm. in size. Minute micropyle cells (68:9) about .0167 in diameter. Greater diameter of egg, .7 mm.; height, .36 mm.

Caterpillar. First stage. Head, chitinous shields of body and all papillae pale greenish fuscous, incisures of head black; ocellar field and region about it blackish fuscous; labrum pale. Body faint greenish white; prolegs concolorous; legs infuscated; hairs as long as three segments; spicules very sparsely distributed, scarcely longer than the diameter of the hairs, and parting from them at a very slight angle. Length of body, 1.6 mm.; breadth, .3 mm.

Second stage. Head fusco-fuliginous, the incisures darker; ocelli white in a black field; mouth parts pale. Body pale mouse brown, the papillae and hairs black; hairs gently arcuate, nearly as long as the width of the body at the extremities, tapering with extreme regularity to the finest possible point, and microscopically spiculiferous; they are mostly arranged in a single, somewhat sinuate, and not entirely regular, transverse series, a little in advance of the middle of each segment. Chitinous shield of first thoracic segment nearly as broad as the head, triangularly produced in the middle anteriorly. Prolegs concolorous, each with about nine or ten hooklets in a single row; legs dark fuscous. Spiracles pale testaceous. Length, 5 mm.; breadth in middle, 1.2 mm.; at either extremity, .8 mm.; of head, .46 mm.

For the next stages see 75:33; 79:43, 44.

Last stage (75:34, 41). Head (79:45) very pale green, a little infuscated, the ocelli black in a dusky field; mouth parts and antennae greenish luteous. Body smoky brown, with a greenish tinge, marked with smoky pallid; the whole dorsal area indeed is smoky pallid, with slender, dorsal and laterodorsal, smoky brown stripes, the former more or less interrupted, and both more or less tinged with olivaceous, especially in front, where the thoracic segments are more or less clouded between the stripes with olivaceous; more or less marked with pallid or whitish at the incisures and the posterior edge of the segments along the stigmatal and infra-stigmatal lines. Hairs mingled blackish and pallid, giving the whole a fuzzy gray appearance; spicules as long as the diameter of the hairs. Along the sides each segment has three or four more or less obscured, blackish, dot-like spots, especially an anterior, laterostigmatal spot, and the fuscous spot in which the minute, pallid spiracle is placed. Legs pale greenish, the last joint more or less luteous. Length, 11 mm.; breadth, 2.5 mm.

Chrysalis (84: 45, 46). Beneath pallid green, flecked with minute brown dots on the wings, legs and tongue, but not on the antennae, and hardly at all on the abdomen, excepting laterally. Head and prothorax pallid, the former flecked with blackish, and the latter with many brownish flecks next the posterior margin; rest of thorax dark greenish brown above, irregularly blotched and flecked with cream yellow, most conspicuously at the summit and down the interior base of the wings; rest of wings pallid green minutely flecked with brown. Abdomen also dark greenish brown, the first two segments darker than the rest and deepening to black laterally next the wings, the whole irregularly flecked above with cream yellow, giving a minutely mottled appearance, and at the sides of the globose portion and on the top of the expanding tip predominating; particularly the lower half of the sides of the fourth abdominal segment are almost wholly cream yellow, and those of the sixth and seventh heavily blotched with piceous. There is a lateral series of short, oblique black bars in the middle of the second to seventh abdominal segments, and the tubercles and the median carina are all tipped with brownish yellow. Surface of body rather coarsely and distantly punctate, with scattered, pellucid, clubbed hairs arising in large measure from the centre of the pits, and but little longer than their widths. Spiracles testaceous. Length, 8.5 mm.; breadth of middle of thorax, 3.65 mm.; of widest part of abdomen, 4.75 mm.; of tip of abdomen, 2.5 mm.; height of thorax, 3.6 mm.; of abdomen, 4.2 mm.; length of hairs, .04 mm.

Geographical distribution (25: 4). The latitudinal distribution of this butterfly is greater than that of any other of the American Chrysophanidi, since it is found from beyond the limits of the Alleghanian fauna on the north, to the extreme southern boundaries of the Carolinian fauna. Its longitudinal spread appears, however, to be far less extended; it is found everywhere east of the Alleghanies, but until recent years it was hardly known west of them. To the north, it reaches Ashbourne, Halifax and Dartmouth, Nova Scotia "very rare" (Jones, Brit. Mus., Redman), Island of Orleans (Bowles), Stanbridge and Cowanville, P. Q. (Fyles), Ottawa "not very rare" (Fletcher), Toronto (Morris, Bethune), Stony Lake (Saunders) and even Sudbury, Ont. (Scudder). The southernmost localities from which it is known are Fernandina, Fla. (Scudder) and Shreveport, La. (Johnson); the westernmost are more vaguely stated excepting that Snow speaks of it as exceedingly rare in eastern Kansas; but it is credited also to Texas, the Mississippi valley, and the Rocky Mountains.

In New England it has been taken in Aroostook Co. (Packard), Brownfield (Haley), Orono (Fernald) and Norway, Me. (Smith); Berlin Falls (Treat, Whitney, Scudder), Fabyans and the Glen, White Mountains (Scudder), Thornton and Waterville (Faxon, Minot) and Manchester, N. H. (Emery); Stowe, Vt. (Miss Soule); the Connecticut valley, Mass. (Emery, Dimmock, Scudder, Sprague); and Plantsville (Shepard) and New Haven, Conn. (Yale Coll. Mus.). It has been taken in the Adirondacks to a height of 1240' above the sea (Keene Valley, Graef).

Haunts. It is found only in the neighborhood of water where alder grows, and is most frequently seen where roads cross some little alder-lined stream, or are carried by an embankment over marshy ground

fringed with alder bushes. It is consequently a very local insect. The observations of numerous observers are nearly identical; one says it is found "about small, running streams and in places protected from the wind" (Dimmock); another "in channels of dry streams between lofty and abrupt hills in W. Va." (Edwards); it "frequents swamps and oak woods" in Georgia, "most frequent in Big Ogeechee Swamp" (Abbot), "resting upon the leaves of trees and bushes growing along the banks of a river" (Smith).

Oviposition. Miss Morton several times observed the butterfly laying her eggs, the first seen being deposited "right in the middle of the aphides" upon a bough of alder. Subsequent observation showed that she "lays her eggs generally close to or among a bunch of aphides, but occasionally on the leaf if it rests on the aphides." In searching for them by brushing away the plant-lice a dozen were found, all on the under side of twigs. Mr. Fletcher also observed a female depositing her eggs and states that "the eggs are generally laid right amongst the aphides, but sometimes outside on the bark, and one egg was laid on a leaf, two inches away from the cluster." The three I have myself found were in identical situations. Several observers have noted the mother's alighting not merely upon alder but upon the plant-lice themselves. The eggs are covered during deposition with a thin coagulated albuminous deposit, which on hardening covers the egg like a thin but irregular veil, rendering it difficult to get any view of its texture; in one instance Mr. Fletcher noticed it "drawn out like a thread of fine silk." The eggs hatch in from three to four days.

Larval food. The reason of all this appears in the fact that plant-lice are the sole food of the caterpillar and that it particularly affects the species which occurs in clusters on alder stems—*Schizoneura tessellata*. According to Riley it has also been found by Mr. Pergande associated with *Pemphigus fraxinifolii* and *P. imbricator*, which feed respectively on ash and beech, both of which, like *Schizoneura tessellata*, "produce much flocculent and saccharine matter." Mr. Pergande also found the larva on witch-hazel. It has also fed in captivity on aphides taken from willow and wild plum (Edwards). Perhaps its natural range is really much greater, for before its carnivorous habits were known it was credited with feeding not only on alder but also on arrow wood, probably a species of *Viburnum*, "winter huckleberry," a *Vaccinium*?, "wild currant tree," *Ribesia*, and *Crataegus*—all on the authority of Abbot, in various published and unpublished notes. Probably plant-lice feeding on these plants in Georgia will be found among its victims. The discovery of its true food was made almost simultaneously by several observers. Late in July or early in August 1880, Misses Soule and Eliot, then summering at Stowe, Vt., brought into the house a branch of alder, white with aphides. "It was left in a corner for a

day or two and meanwhile small, greenish caterpillars appeared about the room, on the walls and bureau. They pupated on the walls, the mop-board, the pin-cushion, the sides of the bureau. The chrysalids were shaped like an ace of clubs." When they emerged the butterfly was identified. "The next year we found one larva on an aphid covered alder, but have never seen one since." This seems to be the earliest observation of the direct association of the caterpillar with the plant-lice, though Abbot records the caterpillar as "covered with a white, loose down"—actually the flocculent secretions of its victims, which become entangled in its hairs; and the following extract from the note-books of the late Dr. Asa Fitch, written January 7, 1855, shows that he had noticed it.

"I wholly forgot the history of these specimens; I find the pupae slightly attached to the sides of a pill box, and the butterflies hatched therefrom; and in the same box some beech leaves and woolly plant-lice (*Schizoneura imbricator* Fb.). I conjecture the worm from which the pupae came must have been feeding among these lice—but have no recollection of the fact." It was not until 1884 that the suspicions of Messrs. Pergande and Riley were aroused. In the following year these observers proved the fact by direct observation, and Mr. Riley published a brief statement to that effect early in 1886. In the same year, in entire ignorance of what had been done, the whole case was worked out with the greatest care by Miss Emily L. Morton of New York, who saw a butterfly deposit an egg "right in the middle of the aphides," observed the larvae devouring the aphides, raised the caterpillars to maturity upon them and found by experiment that they utterly refused to eat the leaves of the trees on which they were found.

Habits of the caterpillar. On this point we are almost entirely dependent on the excellent observations of Miss Morton and Mr. Edwards. The young larva eats a hole through the summit of the egg, does not devour more of the shell, but

pushes its way under the larger aphides . . . and forthwith begins to spin for itself a loose web, not close enough to conceal it from view were the aphides away, but sufficient to keep the aphides from walking over the body, and to protect it when the moult is approaching, and the skin sensitive. The web seems to be just about the length of the larval hairs from the body. The aphides may be seen running over it, and often get their legs fast in the meshes, and are very apt to be devoured as a consequence.

Apparently both the first and second moults are passed beneath this filmy web; but after the second moult (they undergo but three), says Miss Morton, "I find the larvae crawling naked on the limb seeking fresh supplies of food"; which found, "they again spin a web, which they leave after the aphides are consumed." Miss Morton thought that in the last stage they no longer attempted concealment, but moved about very quickly. Some which I obtained, however, remained in the web until ready to change

to chrysalis; so that probably the supply of plant-lice may have much to do with their later action. If abundant, they will burrow and weave their film as before; if not, will, as Miss Morton says, "eat roads through" the mass, "but still [devour them] from the under side, their backs covered with wool from the unlucky aphides. I think the wool prevents eating from above, for I noticed the larvae eat the red aphides from cherry from the back, or wherever they seized them."

When the stem supporting one of these colonies of plant-lice with the caterpillars feasting in their midst (75: 43) is jarred, the latter, unless closely protected by web, are very apt to curl and fall to the ground, apparently by intention. Or they may drop by a thread for several inches and then regain their place, even though they are tolerably large,—a very unusual thing for most butterfly caterpillars, as remarked by Mr. Edwards. Besides the protection this and the web afford, their hairs catch the wool of their devoured victims and renders them, even when moving freely about, not noticeably distinct from the aphid masses.

Life history. The localization and consequent comparative rarity of this butterfly with the recent nature of our knowledge of its habits makes its life history still a little obscure. Probably there are three broods in the north, four in the middle and five in the farthest southern states. The winter is probably passed in chrysalis, but it is not impossible that it may also winter as a butterfly, for at least battered specimens have been taken on the wing very early in the year before the complete unfolding of the leaves, and butterflies have been known to emerge from the chrysalis as late as the last of September.

The first brood of butterflies of the year appears in New England about the beginning of the last week in May and continues upon the wing until after the middle of June. The second brood appears early in July and becomes abundant by the middle of the month; search at Granby, Mass. on July 28 brought to light only caterpillars in the second stage; a fresh specimen and full grown larva were taken by me as far north as Sudbury, Ontario—the northernmost point yet recorded—on July 13, showing that even there the second brood appears at this early date; fresh specimens may still be found during the whole of July and rubbed ones during August; Mr. Fletcher found a much worn female ovipositing at Ottawa on August 2 and they continue upon the wing until the third brood appears, about the middle of August, from which time fresh specimens continue to come out until near the end of September.

One of the remarkable things about this extraordinary butterfly is the rapidity of its transformations in the preparatory stages. As Edwards and Miss Morton have shown, the eggs hatch in three or four days, and the caterpillar not only undergoes only three moults, but makes these with extraordinary rapidity, so that in specified instances only thirteen days

elapsed from deposition of egg to formation of chrysalis, a period shorter than any known to Mr. Edwards with his unsurpassed experience in this line and quite unprecedented in literature. The chrysalis hangs the normal length of time, from eight to eleven days. Comparing this exceptional brevity of the cycle with the ordinary intervals between the broods, the first two of which appear to be fairly distinct, and in no case to overlap, it would seem to follow of necessity that the butterfly does not lay eggs immediately after emerging, but waits long enough to make up for the heightened activities of her progeny. The precarious nature of their food supply and the special danger from the ants, to be mentioned further on, sufficiently accounts for the precocity of these earlier stages of life.

In the central region of its distribution there are probably four broods, for Mr. Edwards recognizes three in West Virginia, one from about April 17 to May 5, corresponding well in season to the first of the north; the second from about June 14 to July 4—a rather short period, but corresponding fairly well to the second of the north; and a third the last of July, which compared with the history farther north, and considering the longer season in the south, must indicate a fourth brood not observed by Mr. Edwards.* If this be the case it is probable that there is an added brood in the extreme south, for Abbot records a caterpillar in Georgia as changing to chrysalis on April 14, which indicates a parent on the wing in March, at the opening of the spring, and so an entire brood in advance of the valleys of West Virginia.

Habits, flight, etc. The butterfly makes short flights and if not alarmed is not difficult of approach, Mr. Edwards relating how he has bottled them directly from their resting place in full sunshine. The flight is rapid and nervous, partaking of the general nature of that of the *Chrysophanidi* and much resembles, though swifter than, that of *Orgyia antiqua*, as Prof. S. I. Smith long ago remarked to me and as Rev. Mr. Fyles observed a couple of years ago. As before stated it is extremely local, apparently wandering rarely more than a rod or two from its birth place. Mr. Emery states that "it is never found around flowers and is usually seen seated upon the upper surface of a leaf, or more commonly on a branch of alder among the wooly plant-lice, enjoying like the ants the honey exuding from their body." This was written before its relation to the plant-lice was known. It selects the leaves of alder for alighting to those of any other tree, and, choosing rather those which are horizontal, faces outward on alighting, with wings partially erect. When ovipositing, according to Mr. Fletcher, "the female runs all over the clusters of aphides with a twitching walk, something like a wasp."

Enemies. The greatest enemies of the caterpillar are apparently the ants, who consider them, and justly, as poaching on their rightful domain.

* Caterpillars were received by him from Washington, D. C. as late as October 4.

No parasites are known; which is the more remarkable as our knowledge of the caterpillar is principally of those taken in the field; evidently their concealment and disguise must thoroughly protect them. But, Miss Morton writes:—

The ants do not let the larvae alone but bite at them furiously whenever they see them; but until nearly grown the larvae lie concealed under the aphides with a web covering them, and cannot be got at by the ants without disturbing their cots. I went to the swamp again to-day. . . . There were places on the limbs of the alder where evidently full grown larvae had cleaned off the aphides. At one place, the ants, a very large species, with black head and abdomen, and red thorax, were in a state of great excitement, running and biting in every direction, and had probably just discovered and routed a full grown larva, as a large brown spot with all the aphides cleared off showed itself on the limb.

That the ants do attack the caterpillars is evidenced by Mr. Edwards's direct experiments with them, and by an observation of Miss Morton's, who, while wondering how she should obtain a caterpillar from a large colony of aphides, found her way "suddenly made plain by a large ant rushing at and biting it furiously, and the larva curled up and fell to the ground." That they actually kill the caterpillar is certain, as the following experiment shows.

I stocked with Aphides an alder I had planted for the purpose in my garden, and on July 31 placed there a caterpillar in the second stage. The aphides were all small and in two large clusters. The caterpillar moved about over the lower colony for an hour or more, apparently looking for a good place to push under it, and I observed its contact with the ants on twenty or thirty occasions. They tickled it with their antennae and it remained at such times absolutely quiet, generally moving off when they left, in the opposite direction to that in which it had been touched. They offered it no further attack. Having to leave for an hour, I found on my return, just at nightfall, that the caterpillar had quitted the lower colony for the upper, six to eight inches distant up the stem, and the same process was repeating with the ants there. The next morning it was found dead beside the colony, the outer edge of which it had eaten and removed, its body bitten just in front of the middle on each side in two or three places. The colony was composed of individuals too young to burrow under and being unable to conceal itself, it had fallen a victim to the ants, then victoriously nursing their colony. With the other attendants of the aphides, the caterpillar of this butterfly appears to be entirely at peace.

Desiderata. The geographical distribution of this butterfly is imperfectly known. Moist spots where alders flourish and their bark is attacked by the plant-lice are the places to search. Especially its west ward and northern extent should be looked to. In Massachusetts it appears never to have been taken east of the Connecticut valley and yet just this region contains most collectors. The reason of such a limitation, if it exists,

should be sought. How it is that when so brief a time is required for the complete cycle from egg laying, broods do not follow each other with greater rapidity? How soon after birth does the female lay eggs? How large a proportion of August chrysalids give birth to the imago in the same year, and how many pass over the winter? Does the imago ever hibernate? and if so in what condition are her ovaries during the winter season? Does the egg ever hibernate, as would seem quite possible from its location? Do any parasites attack the egg or caterpillar successfully? Do ants ever destroy the egg or the caterpillar? What is the actual time required for moulting, including the rest anterior to it? Does the caterpillar ever moult more than three times? The flight and postures of the butterfly are unknown; and it would be well to determine whether the butterfly, whose tongue is short, ever seeks the juices of the plant-lice for its own delectation.

LIST OF ILLUSTRATIONS.—*FENISECA TARQUINIUS*.

Egg.

- Pl. 65, fig. 24. Plain.
68:9. Micropyle.

Caterpillar.

- Pl. 75, fig. 33. Penultimate stage.
34, 41. Full grown caterpillars.
43. Alder twig, with colony of plant-lice attacked by a caterpillar.
70: 63. Head, third stage.
44. Head, fourth stage.
45. Head, fifth stage.

Chrysalis.

- Pl. 84, figs. 45, 46. Side views.

Imago.

- Pl. 5, fig. 8. Female, both surfaces.
34: 35. Male abdominal appendages.
39: 24. Neuration.
55: 11. Side view with head and appendages enlarged, and details of the structure of the legs.

General.

- Pl. 25, fig. 4. Distribution in North America.

III.

FAMILY PAPILIONIDAE.

TYPICAL BUTTERFLIES.

Papilionides (pars) Latr.; Papilionida (pars) Leach; Papiliones (pars) Dalm.; Papilionidae Leach; Papilionidi (pars) Boisd.; Papilionites (pars) Newm.; Papilioniens Blanch.-Brulle; Papilion Luc.	Chilognathiform or Iuliform stirps Horsf. Succineti (pars) Boisd.; Succinctae Boisd.; Succincta Gerst. Cylindracei seu Vermiformes Newm. Fusiformes (pars) Guen.
Hexapodes (pars) Dalm.; Hexapi Guen.	

O la più vaga immagine
Dell' anima immortale,
Chi ti vesti d' un' iride
L' aereo vel dell' ale?
Chi ti spirò l' amore
L' arcano amor del fiore?
Forse quel genio incognito
Che il mio pensier colora?
Che d' un sorriso angelico
M' inebria em' inamora?
Che de' gentili catena
Alla virtù m' affrena?

Ma tu compagna al zeffiro
Paschi e valsee travoli,
E breve giola al calice
Di mille rose involi,
Nè ritrovar tu puoi
Chi fermi i vanni tuoi.
Mentre io delibo il nettare
Di mille gaudi in una,
E non mi duol se l' aere
Sul caro corpo imbruna,
Che non offendo il gelo
Un fior cretto in cielo.

MAFFEI.—*La Farfalla.*

Imago. Head rather large; front nearly square; antennae inserted in distinct pits, entirely within the sides of the front, near together, not infringing on the eyes but open toward them; the club straight or arcuate; eyes prominent, projecting.

Prothoracic lobes very minute, often lamellate. Thorax moderately stout, not much compressed, the upper surface considerably arched, but a little depressed above, the middle of the front of the mesoscutellum projecting very sharply and to some distance between the mesoscuta, the suture between the two scarcely marked by a sulcation, and sometimes even difficult to see, the posterior curve formed by the mesoscutum and the mesoscutellum together elliptic; metathorax very conspicuously separated from the mesothorax.

Wings varying exceedingly in shape, but the fore wings never angulated and very seldom crenulate. Fore wings: costal nervure terminating at from one-half to three-quarters the distance from the base to the apex of the costal margin; subcostal nervure with three or four superior simple or compound branches, of which usually two are thrown off before the tip of the cell and one inferior simple branch*, the nervure itself reaching the border near the apex of the wing; discoidal cell closed by strong veins; median nervure with three or four branches, itself not reaching the border; internal nervure very short indeed and usually delicate. Hind wings: costal nervure terminating at or near the apex of the wing, usually sending upward from near the

*Extraordinary exceptions occur in the Pierinae, as will be seen from the description of that subfamily and in some of the details given thereunder.

base a curving precostal shoot; subcostal nervure with three branches, itself not reaching the border*, the discoidal cell closed by a vein connecting the subcostal and median nervures beyond the second divarication of either; median nervure with three branches in the outer half of the cell, itself not reaching the border; submedian nervure terminating at the anal angle; internal nervure sometimes absent.

Fore legs similar to the other pairs; and in both sexes more nearly approaching them in length than in any other family of butterflies, the fore tibiae and tarsi together averaging in our species only from one-sixth (Papilioninae) to one-eighth (Pierinae) shorter than the length of the hind tibiae and tarsi; tarsi devoid of scales.

Eighth abdominal segment of male differing in outline of hinder border from the preceding, usually produced above into a long, beak-like, curving hook, closely resembling the upper organ of the abdominal appendages of other groups and perhaps often performing its office, but sometimes, on the contrary, notched. The real upper organ may either be of the ordinary type, lying beneath the hook of eighth segment, or it may be nearly aborted, reduced to minute, transverse ribbons. Clasps large, oval, convex, valve-like, their edges meeting so as completely or almost completely to close the extremity of the body, the edges usually smooth, but the interior often supplied with spinous ribbons or ridges.

Egg. Of one of two types: either tall and slender, more or less fusiform, traversed by vertical ribs and crossed by fine lines; or spheroidal, more or less oblate, sometimes so much so as to be tigrate, the surface reticulate with impressed lines, either so distinct as to elevate the enclosed cells, or so obscure as to be nearly invisible.

Caterpillar at birth. Head smaller or at least no larger than the thoracic segments, usually smooth or nearly smooth. Body furnished with longitudinal series of longer or shorter, smooth, hollow, apically expanding bristles, mounted on tubercles of greater or less size and sometimes clustered upon very large ones.

Mature caterpillar. Head free, generally well rounded, furnished to a considerable extent with hairs mounted on little warts, but never with more conspicuous armature. Body cylindrical, long and slender, largest either in the middle or on the hinder thoracic segments, tapering more or less toward either end; sometimes two or more consecutive segments, especially on the hinder part of the thoracic portion of the body, are enlarged and form a common swollen mass; the body is never moult-form, that is, single segments are never arched longitudinally to any observable extent; furnished with hairs only, or also with smooth lenticular warts or with fleshy filaments; spiracle of the eighth abdominal segment on a line with the others.

Chrysalis. Body thickened in the middle and tapering considerably at either end; more or less angulated and with certain parts excessively produced. Head anterior to the prothorax produced anteriorly in front, either at the sides forming ocellar prominences, or in the middle; the mesonotum is elevated and generally the lower surface is considerably swollen in the middle of the wings. Wings not thickened at their immediate borders but continuous with the body, and with a more or less distinct ridge along the whole extent of the sides. Cremaster linear, stout, protuberant, the hooklets placed at tip, not very long but stout, their apical portion bent strongly over like a crook, thickened greatly and at the same time expanded laterally, forming a broad dome or cup-shaped hook. Suspended by the tail and girt around the middle of the body.

Characteristics of the family. This family, like the Nymphalidae, contains very few small insects, rather those of large size; it is found in all parts of the world from the frozen north to the equator; with the exception, however, of a few genera peculiar to temperate regions, the immense majority of the species occur within the tropics. They are about equally divided between the Old and the New Worlds. An unusually

* Exceptions will be noted in Pierinae.

large proportion of the New England genera is represented in the Old World either by species of the same genus or by closely allied genera; yet with the exception of one recently introduced no identical species are known.*

In structure, the Papilionidae show an approach to the lower Lepidoptera. The front legs of both sexes are equally perfect and are always used in locomotion. A large number are provided, as in the Hesperidae, with a lanceolate appendage upon the fore tibiae. The caterpillars are never spined, but either naked, sparsely pilose or provided with fleshy filaments. They are usually solitary, but there are occasional instances of gregarious caterpillars in both divisions of the family. The chrysalids are attached by the tail and by a *loose* girth around the middle, and, in a few instances, are enclosed in a fragile cocoon.

In one instance the mode of suspension is altogether unique. In all the three species of the genus *Thais* found in Europe, the anterior extremity of the chrysalis is furnished with a double tubercle, bristling with short curving hooks, and the chrysalis, besides being attached in the normal way of the Papilionidae by the hinder extremity and the girth around the middle, has also an additional support by the entanglement of these anterior hooks in a loop of silk, spun by the caterpillar in preparing for pupation and which seems to spring from about the same point as the transverse loop of the thorax. There seems to be very little reference to this peculiar mode of suspension by those who have treated of this genus, although it was distinctly mentioned by Rambur as long ago as 1840 in his *Faune entomologique de l'Andalusie*. Boisduval, Rambur and Graslin in their work on European caterpillars describe and figure two species and Duponchel gives an independent description and figure of one of them,—all without reference to this peculiar mode of suspension or to the unique structure of the anterior extremity, to which there appears to be no parallel in the Lepidoptera. Rambur, in the work referred to, writes to this effect: the anterior extremity which is pointed and bifid is also furnished with little short thick hooks, which hook themselves in two bundles of thick silk and it is thus supported by ~~the two~~ extremities besides by the light band of silk which embraces it. Yet Doubleday in 1846 says that "according to Dr. Rambur, when about to undergo their metamorphosis they not only fasten themselves by a *transverse* thread like the *Parnassii*, but also surround themselves by a very slight silken web," which Rambur nowhere asserts, and which is an entire mistake. Hübner figures the chrysalids of *T. polyxena* with the cremaster raised and quite free of silken attachments.

Its affinities. As the relations of this family to others have been the subject of much dispute, it may be well to point out in more detail than

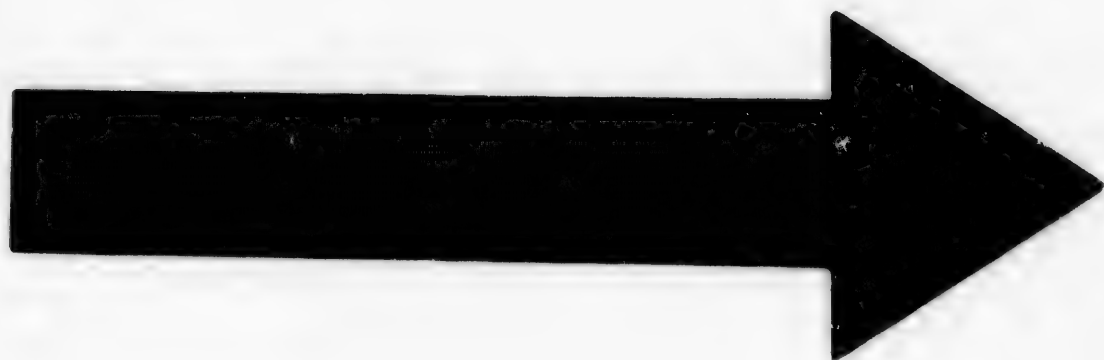
*Doubts, however, have been expressed concerning the distinction of several species.

has been given hitherto the reasons for placing it in a position next to the lowest butterflies. This has already been done in part in the Introduction to this work (pp. 70-75), where, in discussing the classification of butterflies, we have pointed out that two series could be followed throughout the entire range of butterflies, in which there was an evident progression in structure and in life between those groups which are here regarded as the lowest and those regarded as the highest,—series which were completely parallel to each other and which could be offset by no similar series following any order whatsoever. These points concern the structure of the fore legs and the mode of suspension of the chrysalis, and need not be repeated here.

It is not essential to the argument to consider the two groups, Pierinae and Papilioninae, equal subordinates in one family, Papilionidae, since whether they are regarded as subfamilies or as independent families of equal taxonomic value with the other family groups discussed in this work, they have been universally considered by all naturalists up to the present time as directly akin to each other, and the relationship has been so evident that it has not been deemed necessary to insist upon it. The quadrate structure of the front of the head, the insertion of the antennae, the relation of the metathorax to the mesothorax, the complete development of the front legs of both sexes, the special development of the dorsal margin of the eighth abdominal segment of the male, the structure of the abdominal appendages of the same sex, the general structure of the young caterpillar with its relatively small head and its armature of apically expanding bristles, the similar structure and form of the mature caterpillar with its relatively smooth head and spineless body, and the precisely similar mode of suspension in the chrysalis, all show that the uniform opinion of naturalists in past time is entirely just. The arguments, however, which have been used in support of the high rank of these insects, have been drawn altogether from structures found in the Papilioninae only; it is not a little singular that not a single one of these characteristics is found in the Pierinae, and as we have already pointed out in the Introduction, every one of the points considered of high importance is most unfortunately chosen, as each can be paralleled in the lower groups and some are features peculiar among butterflies, not to the Papilioninae alone but to the Papilionidae and Hesperidae, and are plain indications of that affinity for the lowest family which is marked in so many different ways. Hence in the following brief review of other points of agreement between the Papilionidae and Hesperidae some of which are here noticed for the first time, we shall draw entirely upon the structure of the Papilioninae.

If one compares the structure of the compound eyes in the entire series of butterflies, he will be struck by the curious fact that there is great difference between them in the extent of the cornea over the globular field,

the whole of which seems adapted to its reception. In the *Lycenidae* scarcely more than the anterior half of the available surface is put to use. In the *Hesperiidae*, on the other hand, the cornea extends over the entire area. In this particular the *Papilioninae* show the greatest resemblance to the *Hesperiidae*, since only a very small portion of the posterior border is lost. If we take the entire structure of the front of the head, we shall notice, as we have pointed out in the analytical table at the beginning of this work, that the marked width which is a characteristic feature of the head of the *Hesperiidae* is most nearly approached in that of the *Papilioninae*, where the front between the eyes is of about equal width and height. Other features of the head tell a similar story; for instance the brevity of the palpi, carried to an excess in most of the *Papilioninae*, is a general feature also of the *Hesperiidae*, although the palpi have here a very different development by their stoutness and compactness, and by their clothing. One of the striking features of the structure of the *Hesperiidae* is found in the recurved antennal club; this is very marked in many instances, though in some, such as the genus *Hesperia*, it is comparatively slight; the antennal club of the *Papilioninae* as a whole, in its arcuate curve and general form, closely resembles the modified type of structure which we find in the genus *Hesperia*; and this is true of no other group of butterflies, with the single exception of some limited divisions of the *Nymphalidae*, such as the *Euplocinae*. Or if we pass to the structure of the wings, there is no part of the body which will better bear out the claim for a close affinity between the *Papilioninae* and the *Hesperiidae*; differing so strikingly as these members do in their general form and size, there is nevertheless a wider departure from other groups and a closer agreement between the two groups themselves in the general plan of their venuration than can be found in any other two equivalent groups in the whole range of butterflies. We have, for instance, in these two groups, and in these only, four branches to the median nervure of the front wing, and not infrequently to the hind wing; so, too, we have in the subcostal nervure of the hind wing only two branches in these two groups, while in all other divisions of butterflies this nervure supports three branches. No cases of parallel importance can be pointed out in the whole series of the diurnal *Lepidoptera*. The inner border of the hind wing is folded longitudinally in narrow plaits in the *Papilioninae* just as it always is in the *Hesperiidae* and very rarely in other butterflies. Moreover, as we have elsewhere pointed out, this is utilized in many males for the concealment of the peculiar sexual hairs, in a manner very similar to the same contrivance in the costal fold of the fore wings of many male *Hesperiids*, and quite unlike anything else in other butterflies. The way, again, in which the metathorax is marked off in a distinct way from the mesothorax in *Papilioninae* finds its best counterpart in the *Hesperiids*;



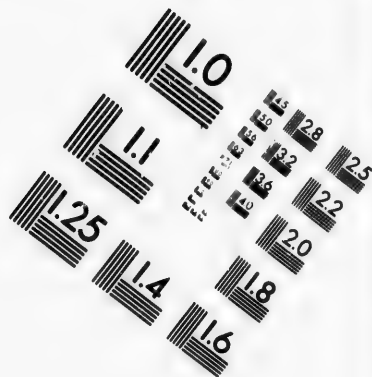
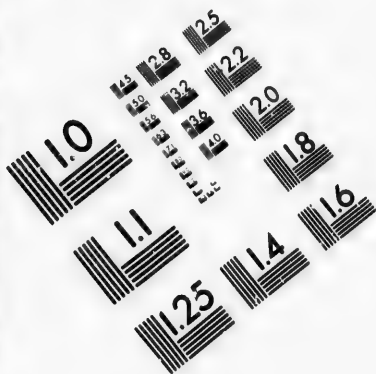
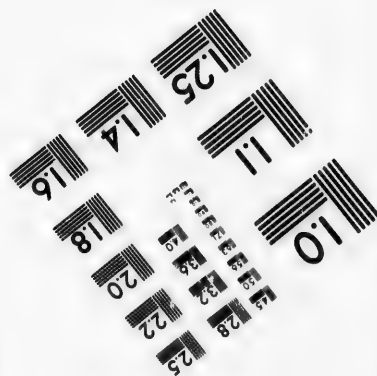
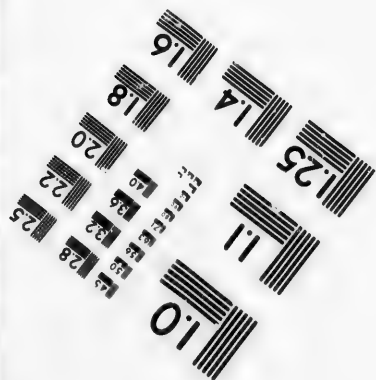
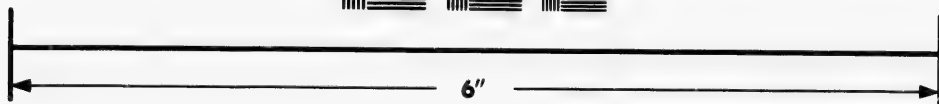
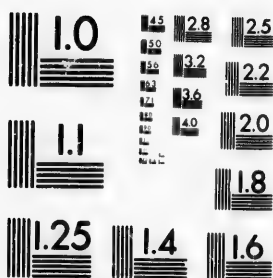


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and in the male abdominal armature there is nothing to parallel the structure of the crinkled ribbons at the base of the centrum in Papilioninae except the inferior armature of the same part in the male Hesperidi.

But although the affinities between these two groups can be pointed out in many more particulars in the structure of the adult animal than in the less known earlier stages, there are not wanting in the latter further proofs of the same relationship. Thus the eggs of all the Papilioninae known, with the sole exception of those of the Parnassidi, are extremely simple and uniform, being subspherical, with a flattened base and almost absolutely smooth, showing, however, a reticulated structure; and they find their nearest approach (with the possible exception of a few of the Satyrinae) in the equally uniform eggs of the Pamphilidi, which differ from them in scarcely any point excepting their broader base and more hemispherical form. In one particular the caterpillars are extremely different from those of the Hesperidae, the Hesperidae being remarkable in their earliest stage for the great size and stoutness of the head and the slenderness of the first thoracic segment, which becomes reduced to a mere neck; almost the exact opposite is true of the structure of the head and first thoracic segment in the Papilioninae, which more nearly resemble in this respect the structure of the Lycaenidae. But the universal presence in each of longitudinally ranged, clubbed bristles in the earliest stage of the caterpillar and the nearly naked form of the body of the mature caterpillar, with the absence of any appendages except delicate hairs or processes of a fleshy nature, show that they are not distantly related. Moreover, in the structure of the internal organization so far as it has been studied, which, it must be confessed, is to an extremely limited extent, the Papilioninae agree better with the Hesperidae than with any other group in the complete coalescence of the terminal ganglia into one, in the excessive length of the stomach at the expense of the oesophagus and intestine, in the delicacy and small development of the malpighian vessels, in the great extent and peculiar disposition of the silk vessels, which is strictly correlated with the exceptional amount of silk frequently spun as a carpet for the resting place of the larva, and in the absence of any divisional clustering of the longitudinal band of muscular bundles upon the sides of the body; while on the other hand hardly a single feature can be pointed out in which they agree better with other groups than with the Hesperidae. In the structure of the chrysalis we have observed no points of special affinity, with the sole exception of the not uncommon unimucronate extension of the front, in which the chrysalids of the Hesperidae find their only analogue in those of the Pierinae.

Table of subfamilies of Papilionidae, based on the egg.

Egg at least twice as high as broad, vertically ribbed.....	Pierinae.
Egg at most scarcely higher than broad, often broader than high, all surface sculpture, when visible, reticulate.....	Papilioninae.

Table of subfamilies, based on the caterpillar at birth.

- Elevations forming the support of the dermal appendages of the body invariably simple, bearing a single bristle.....**Pierinae**.
 At least some, often nearly all, the elevations forming the support of the dermal appendages of the body compound, bearing several, sometimes many bristles.....**Papilioninae**.

Table of subfamilies, based on the mature caterpillar.

- Head moderately small for the body, above with a distinct though short, posteriorly descending surface; no osmaterium, but the body studded with numerous bristle-supporting papillae, many of the bristles apically enlarged; body never enlarged in any part, though often tapering forward in the thoracic region.....**Pierinae**.
 Head very small for the body, above with no posteriorly descending surface whatever; first thoracic segment furnished above with a forked extensile osmaterium, or scent organ; most of the surface of the body naked,* with exceedingly few fine hairs (some of which are apically enlarged) mounted on little papillae; body frequently enlarged at the posterior part of the thoracic region.....**Papilioninae**.

Table of subfamilies, based on the chrysalis.

- Anterior extremity ending in a single conical projection thrust some distance in front of the base of the antennae; dorsal ridges of thorax and abdomen wholly mediadorsal....**Pierinae**.
 Anterior extremity either ending in a pair of projections thrust some distance in front of the antennae (as in all eastern American forms), or with rounded front not projecting beyond the base of the antennae (Parnassidi), occasionally (Thais) with a double knob of hooks for the anterior fixation of the chrysalis; dorsal ridges of thorax and abdomen mostly laterodorsal.....**Papilioninae**.

Table of subfamilies, based on the imago.

- Antennae straight; median nervure of fore wings with three branches; hind wings partially enclosing the abdomen; fore tibiae with no epiphysis; claws bifid.....**Pierinae**.
 Antennae more or less arcuate; median nervure of fore wings with four branches; hind wings not enclosing the abdomen; fore tibiae with a distinct epiphysis on the inner side; claws simple and long.....**Papilioninae**.

SUBFAMILY PIERINAE.

- | | |
|--|--|
| Danae candidi Linn.; Danae Borkh.; Candida Grav. | ridae Doubl.; Pierioides Koc. - Pierinae |
| Andropoda Hübner. | Bates; Pieridina Herr.-Schaff. |
| Pierides Boisd.; Pierites Blanch.-Brullé; Pie- | Helleonides Wallengren. |
| | Granulosae Guenée. |

So glücklich was er: sei hadd binah vergeten,
 Dat sei in 't Gottshus gieng, un up en Hor
 Haddt s' mit dat Sang'bank nah en Rottervangel smeten.
 So glücklich stunn lütt Därten dor!

REUTER.—*De Reits' nah Belligen.*

Imago. Butterflies of medium size. Head rather large; front more or less tumid, usually most so in the middle; occiput with a transverse, elevated field behind the antennae, whose front edge is abrupt, giving it the aspect of a ridge; antennae rather slender, scaled, straight, of about the length of the abdomen, consisting of from thirty to forty-five joints, the club usually rather distinct, cylindrical or depressed, varying considerably in form, occupying from a fourth to an eighth of the whole

* At least in the Papilionidi, which is the only tribe found in eastern America.

antenna; palpi varying in stoutness, longer than the eye, but never twice as long, the basal joint usually developed to an extraordinary length, the scaly clothing compressed in a vertical plane.

Prothoracic lobes minute, a very little tumid. Thorax not very stout, a little compressed; middle of the front of the mesoscutellum not projecting so far between the mesoscuta as in Papilioninae, much the larger portion remaining unenclosed and extending broadly to one side and the other; metascutellum scarcely visible from above, becoming entirely vertical; metascuta large, tumid throughout.

Fore wings usually broad, often very broad (but in some, especially mimetic, species narrow), the apex rounded or angled, occasionally subfalcate; usually the outer border is slightly rounded or straight, occasionally slightly excised, never crenulate. Costal nervure terminating at the middle of the costal border or but little beyond it; subcostal nervure usually with three superior branches, of which generally but one is emitted beyond the cell and is forked at tip; but this nervure is subject to extraordinary variation: sometimes there are but two branches, the terminal forked, sometimes three simple ones; sometimes the lower fork of the outer one itself divaricates, and even sometimes (e. g. *Leucophasia*), the first (and only) branch, arising beyond the cell (which in this genus is excessively short) itself bears all the offshoots, three in number; the simplest formula for this seems to be, that the subcostal nervure gives rise to three superior branches, the outermost usually branched; by a transposition of the branches from the main stem to one of the dependancies (as sometimes happens to a slight degree upon opposite wings of the same insect), these divergencies are reduced to a uniform type, such as is exhibited by *Eurynus*; discoidal cell not broad, usually about half the length of the wing, but varying greatly; median nervure with three branches, the first arising a little beyond the middle of the cell; not connected at base to the submedian nervure. Hind wings broadly rounded, never crenulate nor strictly tailed, but occasionally angulated in the lower median interspace. Costal nervure terminating near the apex on the costal margin, sometimes emitting upward a short, curved branch near the base; united to the subcostal nervure only at the base; subcostal nervure united to the median nervure at an equal distance beyond the second divarication of either, by a long vein, often slighter than the others, directed outward in passing downward*; first branch of median nervure arising at the middle or some way beyond the middle of the cell; internal nervure terminating beyond the middle of the inner border; inner border not plaited, but forming a distinct channel for the abdomen.

Legs moderately long, the middle pair slightly longer than the posterior; tibiae sparsely clothed with scales; fore tibiae destitute of a foliate appendage; tarsi furnished above with numerous spines, irregularly disposed, below arranged in four longitudinal rows; claws short, strongly curved, split to the middle; paronychla usually forming a lateral protecting lobe of large size; pulvillus pedicelled.

Upper organ of male abdominal appendages large and well developed, the centrum stout, the hook simple, tapering, curved downward. Clasps occasionally developing incurved, pointed laminae on their superior and posterior borders, but seldom armed with prickly prominences on the interior surface.

Egg. Very tall and slender, tapering toward a much smaller, rounded summit, either squarely truncate at the base, or tapering as much or nearly as much as at the summit, so as to render the egg subfusiform; provided with a variable number of distinct, longitudinal ribs and crossed by frequent transverse, finer, raised lines.

Caterpillar at birth. Head free with a descending posterior surface above. Body cylindrical, armed with three rows of tubercles on either side above the spiracles, one to a segment on each, and on the abdominal segments placed alternately on the anterior and posterior parts of the segment, everywhere simple and as long in the middle as at

*In *Leucophasia* the first and second subcostal nervules are united at their base for a long distance, so as to appear like a single

forked branch emitted from the upper angle of the cell; and the cell is closed by a vein as in Papilioninae.

the extremities of the body; and below the spiracles another row sometimes with two tubercles to a segment, all bearing longer or shorter appendages which expand at tip.

Mature caterpillar. Head but slightly or not at all narrower than the first segment of the thorax, entirely free from it. Body cylindrical, nearly uniform in size throughout, tapering a very little forward on the anterior half and generally a little more backward; each segment divided transversely by slightly impressed lines into several divisions and the whole body clothed uniformly and only with short hairs arising from minute warts, the larger ones arranged in transverse rows. First thoracic segment without osmaterium. Body longitudinally striped, especially along the dorsum and in the neighborhood of the spiracles.

Chrysalis. Head furnished with a single, central, apical, conical prominence; without ocellar protuberances. Dorsal surface of the abdomen, when ridged, raised along the dorsal line. Posterior edges of the wings forming with each other but a slight, if any, angle. The girth passes across the middle of the first abdominal segment.

The distribution of this subfamily is similar to that of the family as a whole, for it is found in all parts of the globe, and is about equally abundant in both hemispheres, while the great majority of its members are confined within the tropics. Bates, however, says that it is "poorly represented in the forest plains of the Amazons," the species being "most numerous in grassy, open and mountainous countries or in districts where the forests are scanty; they abound in the varied mountainous regions of Columbia" (Journ. entom., 1861, 229). Several genera are common to both worlds but these are principally confined to temperate regions. Wallace reviews in the Transactions of the London Entomological Society (Ser. 3, vol. iv) the distribution of this subfamily and reckoning the species at 760 finds the neotropical region the richest of the six zoological divisions of the earth as given by Sclater, containing nearly two-fifths of the whole, more than double that of any other region excepting the Indian, which possesses rather more than one-half that of the neotropical; the two arctic regions are of course the poorest, the palaearctic, which has nearly double the number of species of the nearctic, possessing scarcely more than one-fifth that of the neotropical.

The butterflies are usually of medium size, nearly always white, yellow or orange and not often greatly variegated. They comprise some of the most delicate of butterflies, as well as some of the strongest winged.

They may be distinguished from the Papilioninae, not only by the absence of some characteristic features of the latter, but also by the split claws, the presence of paronychiae on the feet, the expansion of the inner border of the hind wings to form a channel for the abdomen, and by their generally rounded, entire and tailless wings, all in direct contrast to the Papilioninae. Some genera indeed, owing to their mimicry of other groups, differ widely from the type in the contour of the wings, yet the general uniformity in this respect is very striking, especially when we consider the great diversity of neuration, particularly in the fore wings.

Wallace, who has given this group particular attention, gives us the following picture (*loc. cit.*):—

The white or yellow colour that characterizes these familiar insects is that which recurs most frequently throughout this group in every country; but in the tropics other forms appear by their side decorated with a variety of colours and assuming to some extent the forms and markings of the more brilliant families of butterflies. It is to be observed, however, that in most cases the ground colour of the insect is either white, yellow or black, and even in those exceptional cases in which the wings are entirely red or bluish gray, the female of the same species, or of one closely allied to it, presents us with the usual simple colours. The rich rufous brown, which so constantly reappears throughout the great family of the Nymphalidae, is not to be met with in a single instance in the whole range of the present family. The metallic blue of *Morpho* and of the *Lycaenidae*, and the rich green of various shades which occurs in most other groups of butterflies are also entirely absent. Although the markings are often very beautiful and very varied, well-formed ocellated spots (almost universal in the *Satyridae* and very frequent in the *Nymphalidae*) never once occur; the only approach to them being the small discoidal ocelli in some species. The form of the wings is generally rounded, rarely angular, and the hind wings are never adorned with spatulate, linear or filiform processes, such as occur frequently in most other groups of butterflies. . . .

It appears, then, that quite independently of structural character, the *Pieridae* possess specialities of colour, of marking, and of form of wing, which in their combinations mark them out as a natural and somewhat isolated group; and strikingly illustrate the stability of type that sometimes obtains in what we usually deem unimportant and very variable characters. At the same time it is to be noted that in the important structural character of the venuration of the wings, few families exhibit so many modifications. . . . The form and texture of the wings also seem very subject to modification within certain limits, as is well seen by comparing the delicate, elongate forms of *Leptalis* and *Leucophasia* with the strong and compact *Callidryas* and *Colias*; and in colouration no contrast can be greater than that between such genera as *Enterpe* and *Gonepteryx*. Perhaps, too, there is no family more generally and uniformly distributed over the whole earth. *Pieridae* inhabit the deserts of Arabia as well as the tropical forests; they sport about the snows of the Himalayas and roam over the icy plains of Siberia. The variety of conditions to which they are subject is therefore as great as can well be conceived, and the considerable generic diversity that exists among them probably indicates a great antiquity for the group, yet the ever fluctuating characters of colour, form and marking have nevertheless their strict limits which they in no case overpass.

"They are very pretty, graceful butterflies, says Trimen, "with a tolerably swift, irregular flight. They seldom rise to any height and settle very frequently on flowers." The tropical species, however, fly higher, "now on the tops of the trees, now down near the ground" (*Collingwood*), though they have apparently the same swift yet uncertain flight most resembling that of their brethren the *Papilioninae*. Above all other butterflies they show a fondness for simple moisture, the males particularly collecting in amazing numbers on the margins of pools and streams. Two accounts of this quoted by Distant from others I am impelled to repeat here. The first is the experience of an entomologist, M. C. Piepers in *Celebes*:—

My companion suddenly exclaimed, as we were crossing a nearly dry brook, "Oh, look what a beautiful flower!" And on looking where he pointed I saw in the bed of

the stream, amongst the damp gravel, a beautiful orange-coloured flower with a white centre, about ten centimetres in diameter. The strangeness of the occurrence led me to step nearer in order to observe it more closely, when what did I see?—the flower consisted of two concentric rings of butterflies (*Callidryas scylla* Linn.), which had closed their wings (which are yellow, and orange beneath), and were busily sucking up the moisture from the damp sand, and thus represented in the most closely deceptive manner the petals of a flower. They surrounded five of another white species of *Pteris* similarly occupied, which thus seemed to form the white centre of the flower. I still remember the amazement of my travelling companion, when on my nearer approach the whole flower dissolved into a swarm of butterflies.

It was probably Pierinae, or principally butterflies belonging to that subfamily, which surprised and delighted Mr. E. L. Arnold in Southern India, on one of his excursions in the dry season. He graphically relates that he "came upon a quiet nullah meandering through the jungle. The bed, by chance, just there was broad and sandy, and the stream a single thread that seemed every moment in danger of vanishing. But to my astonished eyes the whole place appeared a garden of flowers of a thousand colours, and crowded so close by the water that the sand could scarcely be seen. I looked and looked again, and then stepped down to observe the parterre closer; but as I did so these animated blossoms sprang into the air in a huge cloud, and the truth was plain that they were a countless host of thirsty butterflies, collected from the forest all round to drink at this thread of liquid." (*Rhopalocera* Malaya, 284-285.)

Perhaps partly in consequence of these habits of assembling, but more probably from some immunity from attack,* no other subfamily of butterflies presents so many instances of swarming propensities, of actual migrations and of destructive tendencies, none where the individuals of a species are so generally numerous. They are the only foes to our vegetable gardens, which is the more marked as the caterpillars of the injurious species do their work for the most part singly and not in companies. As this topic will be referred to at length in an excursus, a few pages further on, and will be illustrated at several points within the subfamily, it need not be further discussed here. It may be mentioned, however, that Wallace suggests that it may be their congregating habits that "lead to their being frequently carried off by winds, and it is thus, perhaps, that some of the species have so wide a range and offer such perplexing variations." Yet how rarely this is true appears in his paper on the Pierinae of the Indian and Australian region, in which 279 species are catalogued. Here he finds but six common to these countries and the palaearctic region. These 279 are nearly equally distributed between the Indian and Australian regions, a slight preponderance being shown in favor of the former, while less than a score are common to the two districts.

The eggs are much taller than broad, taller than those of any other group of butterflies, even fusiform, and are always vertically ribbed. They are almost invariably laid singly, but sometimes in open clusters. The juvenile caterpillars are furnished with club-shaped hairs, varying in

* It is stated (see *Psyche* iii: 47) that ninety ducks were once turned into a European cabbage field infested with the caterpillars of *Mameplum brassicae*. In one afternoon the

field was almost clear, but two ducks died after an hour. The next morning twenty were found dead, and altogether fifty-three perished.

length. The mature caterpillars have a small head and are uniformly cylindrical, slenderer than usual, and almost invariably sparsely pilose, with very short hairs; some exotic species have long, scattered hairs.

They feed exclusively on polypetalous plants and almost wholly on Leguminosae and Cruciferae; sometimes the neighboring families are selected. They are generally solitary, or at most, where the eggs are laid in open clusters, as in *Mancipium brassicae*, semigregarious. But there are others which are strictly social, such as *Aporia crataegi* of Europe, where the caterpillar lives in company beneath a web spread over the hawthorn bushes; and a Mexican species, *Eucheira socialis*, found at an elevation of 3200 metres above the sea, where the nest, as described by Humboldt and Westwood, is eight inches long, and made of tough layers of parchment-like silk, which Humboldt says can be used as writing paper, and indeed was used as such by the early Spanish fathers; it is suspended from a tree and has a hole in the bottom for the entrance and exit of the caterpillars; within this sac they undergo their transformations, and being thus protected the chrysalids are attached to the inner walls by their hinder extremity only, having no need of the supporting girth that is otherwise invariably used throughout this family. Mr. Auguste Sallé opened a nest which he brought to Paris from Mexico, and showed me the chrysalis skins hanging in profusion, just as they are depicted in Professor Westwood's plate; there was certainly no sign of a girth. Rambur (*Faune ent. Andal.*, 249) says that the caterpillar of *Zegris eupheme* spins a sort of strong gauze envelope, within which the chrysalis hangs by its hinder extremity and is further supported by an almost invisible band around the body.

The chrysalids may be distinguished at a glance from all other butterfly pupae (excepting some *Libytheinae* and *Hesperidae*) by the presence of a single pointed projection in front; sometimes this is excessively long, often curved upward, and occasionally, as in the *Anthocharidi*, the extension of the abdomen forms a similar prolongation at the other extremity, so that the whole presents an oddly bisymmetrical appearance; the chrysalis is frequently bent backward and the edges of the wing-cases often project beneath. Nearly all the chrysalids of this subfamily are remarkable for their imitations of the colors of their surroundings, sometimes even of the form of seed-vessels or leaves of the food plant of the caterpillar, and have been the subject of some curious experimentation in this direction, as will be elsewhere described.

The insects of this subfamily are generally double brooded or polygynous, and may pass the winter in any stage excepting that of the egg. The butterflies live in the open country,—Wallace calls them "open ground butterflies"; and Bates speaks of them as "a conspicuous feature in the fauna of temperate latitudes"; certainly they are here familiar sights to every one.

Mimicry in this group is frequent and often almost complete. "The genus *Leptalis*," writes Bates (*Journ. ent.*, 1861), "was supposed, both by Boisduval and Doubleday, to have a real affinity with the *Heliconidae*, as the species not only resemble that family in shape, markings and colours, but they also have, as Doubleday states, a structural similarity to species of *Ithomia* (a *Heliconideous* genus) in the neuration of the wings. The two groups furnish a most curious instance of deceptive analogical resemblance. There is, in truth, the widest possible difference between the two in all essential characters of affinity—a fact which a careful study of the legs in the *Rhopalocera* will satisfactorily prove. . . . The species [of *Leptalis*] in the Amazon region are also extremely rare; they inhabit the shades of the forest, and mimic the different species of the dominant group *Heliconinae*, in whose company they are always found, thus suggesting the idea that it is only by means of this close, adaptive resemblance that they escape total extinction."

Several fossils belonging to this subfamily have been found in the tertiary of Croatia and southern France, and a single one in the beds of a similar age in Colorado.

Table of tribes of Pierinae, based on the egg.

- Egg distinctly fusiform, rounded at each end, the base at most scarcely more than half as broad as the middle; vertical ribs very slightly elevated, delicate, generally numerous. **Rhodoceridi.**
 Egg obscurely fusiform, the base tapering but little, truncate, generally three-quarters the width of the middle; vertical ribs distinct, sharp and moderately prominent, and comparatively few in number.
 Summit of egg distinctly rounded. **Anthocharidi.**
 Summit of egg distinctly truncate. **Pieridi.**

Table of tribes, based on the caterpillar at birth.

- Uppermost serially ranged appendages of body approximated in laterodorsal rows.
 Dermal appendages conspicuously longer at the extremities of the body than in the middle. **Rhodoceridi.**
 Dermal appendages of nearly uniform length throughout the body. **Pieridi.**
 Uppermost serially ranged appendages of body widely separated in rows not higher than a supralateral line. **Anthocharidi.**

Table of tribes, based on the mature caterpillar.

- Either all the hair supporting papillae of the body are of equal or subequal size, or the larger ones are numerous and arranged in transverse and not longitudinal series; longitudinal markings comparatively rare; body tapering forward in front, the front pair of legs noticeably smaller than the succeeding. **Rhodoceridi.**
 The hair supporting papillae are of unequal size, the larger generally conspicuous, moderate in number and arranged in longitudinal and (excepting on the thoracic segments) not in transverse series; longitudinal markings comparatively common; body scarcely tapering forward in front, the front pair of legs only slightly smaller than the others.
 Whole body comparatively slender; head much broader than high; abdominal segments usually divided into seven sections. **Anthocharidi.**
 Whole body comparatively stout; head scarcely or not at all broader than high; abdominal segments divided into six sections. **Pieridi.**

Table of tribes, based on the chrysalis.

Wing cases decidedly protuberant below the general course of the under surface of the body; tongue and antennae not nearly reaching the uncovered part of the abdomen; carinae of body rarely raised to abrupt angles or points.

Anterior and posterior halves of body heteromorphous, sometimes the one, sometimes the other the slenderer, the head usually well distinguished from the frontal prominence....

Rhodoceridi.

Anterior and posterior halves of body homomorphous, the former the slenderer, the head scarcely distinguishable from the frontal prominence.....**Anthocharidi.**

Wing cases not protuberant below the ventral line; tongue and antennae reaching the uncovered part of the abdomen; carinae of body generally raised to sharp projections, especially about the middle of the thorax, and the basal half of the abdomen.....**Pieridi.**

Table of tribes, based on the imago.

Antennae gradually increasing in size, the club ill-defined, slender, cylindrical and apically subtruncate; palpi stout, the apical joint short; prevailing colors yellow....**Rhodoceridi.**
Antennae with a distinct, broad, subspatulate, depressed club; palpi slender, the apical about as long as the middle joint; prevailing colors white.

Third subcostal nervure of fore wing forked near the middle; precostal nervure of hind wing straight; middle tibiae shorter than femora; eighth abdominal segment posteriorly prolonged above in the male.....**Anthocharidi.**

Third subcostal nervure of fore wings forked at extreme tip only; precostal nervure of hind wings strongly bent outward; middle tibiae at least as long as femora; posterior margin of eighth abdominal segment entire or notched above in the male.....**Pieridi.**

TRIBE RHODOCERIDI.**YELLOWS OR RED-HORNS.**

Danai flavi Wiener Verzeichniss.
Fugacia + Eldella Hübner; Fugacia Scudder.
Colianae Swainson.

Rhodoceridae Duponchel; Rhodoceridi (pars) Stephens.

Seven gold butterflies flitting overhead.

Lilliput Levee.

Imago. Prevailing colors yellow and orange, marked with black. Head: Front but little and always irregularly tumid; antennae moderately stout, equal to or shorter than the abdomen in length, the club ill-defined, increasing in size very gradually, cylindrical or depressed, long and rather slender; palpi very short, less than half as long again as the eye, moderately stout, with a very thin and short fringe of hairs, if any; apical joint minute, the basal extraordinarily large, at least as long as the middle joint and sometimes more than twice as long. Patagia long and slender, the posterior lobe considerably elongated; the third branch of the subcostal nervure of fore wings with a long fork; precostal nervure of the hind wings very short or altogether wanting; middle tibiae of the male shorter than the femora. Eighth abdominal segment of male prolonged above, usually as a distinct hook, but sometimes as a laminate expansion; hook of upper organ of appendages small; posterior edge of clasp produced once or twice to a point, usually incurved.

Egg. Tall and very slender, pretty regularly fusiform, only larger below than above, the summit delicately rounded, the vertical ribs pretty numerous, not high, but delicate and distinct.

Caterpillar at birth. Appendages of body rather or very short and expanding greatly at tip into a wine-glass or club shaped bulb almost or quite as broad as long; the uppermost series laterodorsal, longer at the extremities of the body than on the middle segments.

Mature caterpillar. Head smaller than any part of the body. Segments divided into six transverse sections; body covered uniformly with equal minute warts, emitting each a short hair, or if unequal the larger are ranged in transverse and not longitudinal series; front pair of legs noticeably shorter than the others.

Chrysalis. Prominences of the body generally rounded; under surface swollen at the middle by the protuberance of the wings; lateral ridge including the upper edge of the wings; apical portion of the wings touching each other, both antennae and tongue falling short of their apex.

The butterflies of this tribe are usually of medium size though more variable than other tribes of Pierinae and their colors are different shades of yellow, marked with black. They are somewhat abundant in the temperate zones and generally very numerous in individuals. Wallace, writing of the Amazons, says (Travels, 65):—"The insects most abundant were the yellow butterflies, which often settled in great numbers on the beach, and when disturbed rose in a body, forming a complete yellow and orange fluttering cloud."

So, too, in our own country Doubleday writes (Arc. ent., i: 144) that he has seen in Illinois, in the autumn, philodice, coesonia, nicippe, lisa and eubule "in groups, literally of hundreds (the first-named insect generally making nineteen-twentieths of the company), on a space not six feet square. The philodices sit with their wings over the back, in rows, quite close together, in fact sometimes touching each other, thirty or forty in a row." Gosse writes of West Indian butterflies (Ann. mag. nat. hist., [2] ii: 114):—

The habit which the yellow Pieridae have of resorting in numbers to the margin of water is common to the Jamaican species as well as their fellows in other parts of the world. During the rainy season, when the afternoon showers fill the hollows of the highways with broad but shallow pools which the intense morning sun either wholly or in part dries up, one may see, towards the middle of the day, each little patch of slushy mud surrounded by a yellow fringe composed of a multitude truly surprising, of these butterflies, large and small, chiefly *Callidryas* and *Terias*, which sit on the very edge of the water, side by side, their wings erect and closed, and their long suckers protruded and busily extracting the moisture. For the most part a considerable number on the wing are hovering about the spot, some alighting and some rising every moment. If compelled to take flight, which they do very reluctantly, the multitude of yellow wings that in a moment throng the surrounding air is quite astonishing and forms a very pleasant sight.

The flight of the butterflies is much stronger and more rapid than that of the other groups of Pierinae—hence Hübner's excellent name for them. The wings of the males are frequently bordered with patches of slightly elevated scales, causing a peculiar lustreless appearance nearly unknown in the other groups of Pierinae. The eggs are always laid singly and are of extraordinary height and slenderness. The caterpillars feed almost exclusively on Leguminosae. The chrysalids are not so elongated as in the Anthocharidi, more rounded and less angulated than those of the Pieridi; their wing cases protrude beneath (often strongly), giving the body a bent appearance.

The fossil remains of a butterfly belonging to this group, *Coliates proserpina* Seudd., has been found in the tertiaries of Aix, France; and another, long known as a *Vanessa*, under the name of *pluto* Heer, in the miocene of Croatia.

Table of genera of Rhodoceridi, based on the egg.

- Vertical ribs comparatively few (less than twenty) and distant.
 Base much broader than summit, the egg not more than twice as high as broad. **Callidryas.**
 Base hardly broader than summit, the egg two and a half times higher than broad..... **Eurymus.**
- Vertical ribs very numerous (thirty or more) and approximated.
 Hardly more than three times higher than broad, considerably broader at base than at summit..... **Eurema.**
 Three and a half times higher than broad, not much broader at base than at summit. **Xanthidia.**

Table of genera, based on the caterpillar at birth.

- Appendages of body as long as the segments that bear them..... **Eurema.**
 Appendages of body no longer than the section of the segments upon which they are seated. **Eurymus.**
- Callidryas and Xanthidia unknown.

Table of genera, based on the mature caterpillar.

- Hair bearing papillae both of body and head moderately conspicuous, distinctly elevated, higher than broad; head relatively narrow.
 Larger papillae arranged in a single transverse row on each subsegment and much greater than the smaller ones; first thoracic legs exceptionally short..... **Callidryas.**
 Larger papillae not definitely ranged transversely, nor much larger than the smaller papillae; first pair of legs shorter than the others but not to so great a degree as in *Callidryas*.
 Papillae of head comparatively large, very high and numerous, the largest of greater diameter than the largest ocelli..... **Xanthidia.**
 Papillae of head comparatively small, moderately high and sparsely distributed, the largest smaller than the ocelli..... **Eurema.**
- Hair bearing papillae whether of head or body mere raised points, not distinctly higher than broad; head relatively broad..... **Eurymus.**

Table of genera, based on the chrysalis.

- Ventral protuberance of wings doubling the depth of the body; frontal process trebling or more than trebling the length of the head above.
 Anterior axis of body bent at an angle of 120° with the posterior axis; fourth abdominal segment with a distinct, sharp, supralateral carina..... **Callidryas.**
 Anterior and posterior axes of body in nearly a straight line; suprastigmatal region of fourth abdominal segment with no distinct carina, at most a broad swelling. **Xanthidia.**
- Ventral protuberance of wings not doubling the depth of the body; frontal process only doubling or less than doubling the length of head above.
 Head above including frontal process twice as long as the prothorax, the process slender, acuminate; cremaster scarcely channelled above..... **Eurema.**
 Head above including frontal protuberance not more than half as long again as the prothorax, the protuberance slightly less than rectangular; cremaster deeply channelled above. **Eurymus.**

Table of genera, based on the imago.

Club of antennae cylindrical, subtriangular, apically truncate.

Middle joint of palpi but little longer than broad; costal margin of fore wings convex throughout; the inner margin sinuate; second superior subcostal nervule arising before the tip of the cell.....**Callidryas.**

Middle joint of palpi fully twice as long as broad; costal margin of fore wing straight in the middle half; the inner margin straight; second superior subcostal nervule arising beyond the tip of the cell.....**Eurymus.**

Club of antennae distinctly depressed, apically tapering to a rounded point.

Hind femora only about three-fifths as long as the middle femora.....**Xanthidia.**

Hind femora about three-fourths as long as the middle femora.....**Eurema.**

CALLIDRYAS BOISDUVAL AND LECONTE.

Callidryas Boisd.-LeC., Lép. Amér. sept., 73 (1829-30). Type.—*Papilio eubule* Linn.

Behold again, with saffron wing superb,
The giddy butterfly. Released at length
From his warm winter cell, he mounts on high,
No longer reptile, but endowed with plumes,
And through the blue air wanders; pert, alights,
And seems to sleep, but from the treacherous hand
Snatches his beauties suddenly away
And zigzag dances o'er the flowery dell.

HURDIS.

Imago (56:1). Head rather large, covered with rather short, very close hairs, having a tendency to form transverse tufts. Front depressed above, tumid on the sides and beneath, projecting considerably beyond the front of the eyes; on the upper half is a slender, longitudinal, median ridge, rather briefly blid at the upper extremity next the hinder edge of the antennae, expanding considerably at the lower extremity; the fullness of the sides is limited by a distinct, rather abrupt, semicircular ridge, hollowed broadly in front of each antenna; as broad as high, nearly as broad as the eye on a front view, the sides scarcely diverging upward; upper border extending rather narrowly between the antennal pits, and following their curve; edge of pits a little rounded; lower border raised a little in the middle, very broadly rounded, almost straight. Vertex rather depressed, a little and broadly tumid along the middle, the upper outer corners produced a little forward and gibbous; anterior border, excepting the corners, straight, falling abruptly so as to form a slightly elevated ridge. Eyes angulated next the front border of the antennae, large, full, naked. Antennae inserted in the middle of the summit in distinct, deep pits, open toward the eyes, separated from each other by a space half as broad as the antennal pits; of the length of the abdomen, composed of forty-three joints, of which the last ten or eleven form the scarcely depressed cylindrical club, which increases so gradually and little in thickness that it is difficult to determine its limits; it increases slightly in size to the very last, the terminal joint as large as the preceding, being very broadly rounded, almost abruptly docked; club less than twice as broad as the stalk and six or seven times longer than broad; each joint has, next the base, on the inner lower surface, a rather large, shallow, oval depression. Palpi short and very stout, compressed, half as long again as the eye, the last joint very minute, the middle about two-fifths the length of the basal joint, which here composes, in place of the middle joint, the bulk of the member, all furnished with a heavy broad mass of closely clustered scales, greatly compressed in a vertical plane, the upper surface of the middle joint broadest.

Prothoracic lobes directed upward and a little inward, the upper surface broadly and regularly rounded, the inner upper angle well rounded, a little produced, below tapering greatly; moderately tumid, but viewed from above strongly appressed, lenticular, the edge uppermost. Patagia rather large, long and slender, scarcely arched, a very little tumid, the outer margin slightly thickened, nearly four times longer than

broad, rather broad and well rounded at base, beyond tapering, especially along the outer border, the apical half one-third as broad as the base, nearly equal, the tip narrowing and bluntly pointed.

Fore wings (40:2) scarcely two-thirds as long again as broad, the costal margin a little expanded at the very base, considerably convex on the basal and apical fourth, the middle half rather flattened; outer margin nearly straight, slightly hollowed near the middle, directed at scarcely less than a right angle to the extreme part of the costal margin, the angle scarcely rounded off; inner margin almost sinuous, the basal half, or rather more, gently convex, beyond about straight, the angle rounded off. Costal nervure terminating at some distance beyond the middle of the costal border; subcostal nervure with three branches, the first arising but little beyond the middle of the cell; second arising shortly before the apex of the cell and the third an equal distance beyond the same, forking at a distance beyond its base about equal to its distance from the second; cell half as long as the wing, slightly longer in the ♂ than in the ♀.

Hind wings with the costal border pretty strongly and roundly expanded at the very base, beyond which the border is pretty strongly and regularly convex, the height of the curve before the middle, and slightly greater in the ♂ than in the ♀; the outer border bent at a little more than a right angle to the outer half of the costal border, nearly straight in the upper third, slightly convex beyond, fuller in the upper half in the ♀ than in the ♂, receding rather rapidly below the lower median nervure; the inner border very greatly, abruptly and squarely expanded at the very base, beyond straight, receding and hollowed slightly beyond the tip of the internal nervure, the angle rounded off. Precostal nervure very short, directed upward; vein closing the cell striking the subcostal and median nervures at about equal distances beyond their second divarication.

Fore tibiae but little more than half as long as the middle tibiae; fore tarsi fully as long as the fore femora and not much shorter than the middle tarsi, although only two-thirds as long as the hind tarsi; hind femora only one-half (♂) or about three-fifths (♀) as long as the middle pair. Tibiae furnished beneath, near either side, with a row of not very frequent, very short and slender spines, on the sides and upper surface with numerous, very similar spines at somewhat similar distances apart. On the sides disposed with some regularity in distant, rather obscure rows; furnished at the tip beneath with a pair of rather short, slender, equal, apically tapering spurs. First joint of tarsi equal in length to the second, third and fifth together, the second, fifth, third and fourth diminishing regularly in size in the order mentioned; all the joints furnished with numerous small, slender spines over the whole surface, disposed in irregular rows above and on the sides, in four nearly equidistant, very regular rows beneath, the apical spines of each joint in the outer rows very slightly larger than the others; claws rather large, widely spreading, slender, compressed, strongly curved, each bifid for nearly half its length, the inner branch parting from the other and curving still more strongly, both finely pointed; paronychial simple, consisting of a long and broad quadrate lobe outside of the claw, as long as it and concealing it laterally; pulvillus of medium size, longitudinally obovate, projected nearly to the tip of the claw on a slender pedicel.

Second abdominal segment one-fourth as long again as the first or third, the latter a little longer of the two; beyond, the segments decrease regularly in length until the eighth is reached, which in the male is broadly produced above to a convex, rounded plate, making this segment nearly equal to the fifth, sixth and seventh together. Hook of upper organ of male stout, strongly compressed, tapering at the base and well arched. Claspers tapering a little, very deeply and almost squarely excised at the upper posterior angle, to half the depth of the apex, and at either limit of the excision produced to a laminate tooth; within, near the centre, an inward directed, rather stout, cylindrical finger, beset with prickles.

Egg. Subfusiform but broadly rounded at base, so as to be only twice as high as broad, with slight, vertical ribs and coarse and distinct transverse lines.

Mature caterpillar. Head rounded quadrate, a little broader than high, well

domed above, flattened beneath, scarcely compressed laterally, broadest at the summit of the triangle; scarcely deeper below than above, the front nowhere appressed, the median suture distinctly impressed on the summit; covered pretty uniformly and not abundantly with tubercles of two distinct sizes, the largest as large as the largest ocelli and occupying principally the summit, each giving rise to a minute hair, which excepting on the cheeks, is short and partially recumbent. Triangle less than half as high as broad, reaching a little above the middle of the front. Antennae with the first joint moderately large, conical (?), the third about half as long again as broad, narrowed at the tip and bearing a long and a short bristle, the former many times longer than the joint. Ocelli six in number, four of them large and prominent, arranged in a gentle curve, the convexity forward, at equal distances apart, except that the lowest is removed a little downward; the other two posterior ones are a little smaller, arranged as in *Eurymus*. Labrum not large, shallowly and angularly emarginate in front. Mandibles small.

Body cylindrical, everywhere larger than the head, tapering a little forward from the middle of the second thoracic segment, and backward on the last two abdominal segments. Each segment divided into subequal parts, exactly as in *Eurymus*, but in addition to the minute, hair-emitting tubercles of that genus, there are a smaller number of larger tubercles, one transverse row to each division of the body. Spiracles, legs and prolegs much as in *Eurymus*, the front pair of legs considerably less than half as long as the others.

Chrysalis. Body cylindrical, tapering at both extremities, its form masked by being bent upward in front, between thorax and abdomen, at an abrupt angle of 45° , and by the immense extent of the wing cases, which form a protuberant, broad, rounded and cuneiform-compressed lobe beneath. Though angulated and slightly protuberant at the basal wing tubercle, the body is nearly of equal width from here to the fourth abdominal segment; behind this the body begins to taper, at first slowly, afterwards rapidly, to the narrow-tipped cremaster; in front it tapers rapidly and regularly toward the base of the long and slenderly conical frontal tubercle. Viewed laterally, the inequality in the size and form is excessive. A slight, concave curve extends from the tip of the tubercle to the summit of the mesothorax, from whence the line descends in a reverse sense to the end of the thorax, beyond which it is normal; beneath, a broad, J-shaped curve extends from the base of the frontal tubercle to the termination of the wings, at the end of the fourth abdominal segment. There is a distinct but not prominent mediodorsal carina over the whole extent of the body; a similar but more prominent lateral carina along the inner edge of the wings and just above the spiracles. The eyes are not at all protuberant, the whole front of the body scarcely convex. Tongue reaching somewhat beyond the antennae, but not reaching the lower portion of the wing lobe. Preanal button scarcely raised above the surface, showing a couple of minute, subdorsal, conical, pointed tubercles, and behind them a pair of scarcely separated, slight, longitudinal, dorsal ridges. Cremaster with a deep, circular, hollowed pit on the ventral face, and a shallower one on the dorsal face, the whole depressed, tapering, truncate, with swollen ridges, with the field of hooklets occupying the apical face and the apical portion of the inferior face, the hooklets much as in *Eurymus*.

This group and *Catopsilia*, its Old World representative, are peculiar to the tropics, where they replace the genus *Eurymus* of the temperate regions. *Callidryas* is twice as numerous as *Catopsilia*, and also spreads further north by means of the single species here described, which has been found even as far as the southernmost borders of New England.

The butterflies are the largest of the subfamily, always exceeding two inches in expanse. They are generally of a uniform greenish yellow,

often with orange disks ; the fore wings and sometimes the hind wings of the female are more or less heavily bordered with ferruginous tints. The wings of the males are rather broadly edged above with raised, mealy looking scales, sometimes darker than the ground color. There is often a small spot at the tip of the cell, especially on the fore wings, which is larger beneath and often double and pupilled with silver.

They are probably double brooded, appearing late in spring and again in autumn ; the imagos are long lived and doubtless survive the winter, as they seem to be found in warm climates throughout the year ; in the autumn they swarm in myriads and having a powerful flight occasionally migrate in flocks. Lacordaire describes their flight as elevated and rapid and adds that they are difficult to catch, often resting on the flowers of high trees. They are very fond of flowers, "rejoice in the hottest sunshine and crowd in dense masses several yards in extent, around puddles and on sandy beaches, rising in clouds of yellow and orange on being disturbed" (Wallace). Bates gives the following account of them on the Amazons :—

As the waters retreated from the beach, vast numbers of sulphur-yellow and orange coloured butterflies congregated on the moist sand. The greater portion of them belonged to the genus *Callidryas*. They assembled in densely packed masses, sometimes two or three yards in circumference, their wings all held in an upright position, so that the beach looked as though variegated with beds of crocuses. These *Callidryades* seem to be migratory insects, and have large powers of dissemination. During the last two days of our voyage the great numbers constantly passing over the river attracted the attention of every one on board. They all crossed in one direction, namely, from north to south, and the processions were uninterrupted from an early hour in the morning until sunset. All the individuals which resort to the margins of sandy beaches are of the male sex. The females are much more rare, and are seen only on the borders of the forest, wandering from tree to tree, and depositing their eggs on low mimosas which grow in the shade. The migrating hordes, as far as I could ascertain, are composed only of males, and on this account I believe their wanderings do not extend very far. (Nat. on Amazons, i:249.)

The caterpillars, remarks Schomburgk, are sometimes eaten by the Indians of British Guiana ; they are roasted and mixed with flour made from the root of the Cassava, etc., and then baked into cakes or mixed with turtle's eggs. The food of the larva appears to be confined to the *Caesalpinieae* (*Leguminosae*) and the chrysalids continue from ten to eighteen days.

The eggs are tall, conical and very strongly constricted at the base.

The caterpillars are yellowish green, the head rather small and the surface of the body more or less granulated, with a pale or colored lateral stripe.

The chrysalids are similarly colored, strongly curved, dorsally concave, the wing cases very large and protruding extraordinarily in a strongly rounded curve, and the anterior extremity produced to a long, conical snout.

EXCURSUS XL.—AROMATIC BUTTERFLIES.

With merry heart, whose flashes rise
Like splendour-winged butterflies
From honey'd hearts of flowers in May.

GERALD MASSEY.—*Babe Christabel*.

Its raiment was the thousand dyes
Of flowers in the heavenly paradise.

HOGG.—*The poetic mirror*.

FRITZ MÜLLER, a naturalist who has done much by his researches in various fields to bring new evidence in support of Darwin's theory, astonished the entomological world about ten years ago with a long list of odors emitted by butterflies and moths. It had been known for a long time that certain butterflies had peculiar odors, but no one imagined the extent and variety of this peculiarity. And indeed this is not altogether strange, since the cases known up to the present time are largely drawn from tropical butterflies, and the odor is always lost after death, and in many cases is exceedingly faint and fleeting. The study of the apparatus through which the odors are emitted shows that three classes of organs are involved in their production, and the variation in intensity of odor in different creatures leads to the very reasonable belief that the identical organs found in an immense number of butterflies where we can perceive no odor, are also scent producers, even though their odors may be too ethereal for human senses.

The odors produced by butterflies are very largely confined to the male sex, evidently for the delectation of their mates, and the organs through which they are produced may be divided into three classes: extensible glands, situated upon the abdomen; tufts or pencils of hairs, found upon various parts of the body, even including the legs and wings; and scales or scale-clusters, confined entirely to the wings. In the first class, that of extensible glands, we have the case of *Anosia* and its allies, the males of which can protrude from the terminal segment of the body, as has already been described in this work, a sac-like finger, bristling with hairs, which upon withdrawal are closely compacted into a pencil. The odor emitted by this organ is said by Fritz Müller to be rather disagreeable when the processes are fully protruded, and as being rather faint in our species. I have never myself experimented with it. Similar organs are found in the allied *Euploeinae*, of some species of which de Nicéville says: "The males . . . may often be observed patrolling a small aerial space, with the end of the abdomen curled under the body toward the thorax, and with the two beautiful yellow anal tufts of long hair distended to their fullest extent at right angles to the body." (*Journ. Asiatic soc. Beng.*, liv: 41). So, too, in the *Heliconinae* similar organs exist and that in both sexes, and the odor is described as of a disgusting nature. The

females of *Melete* and *Callidryas*, genera of *Pierinae*, have similar organs in the female, possessing a peculiar odor, and the males of some species of *Morphinae* "are able to protrude from the end of the abdomen a pair of hemispherical bodies covered with short hairs which produce a very distinct odor." So, again, both sexes of a species of *Didonis*, one of the *Nymphalinae*, protrude from the dorsal side of the abdomen, between the fourth and fifth segments, hemispherical protuberances which have a rather disagreeable and strong odor; and what is the more remarkable, in addition to this, the male of the same species has a second pair of similar protuberances, between the fifth and sixth segments, which are white and "emit an agreeable odor, comparable to that of *heliotrope*."

With the second group, where the odors have their origin in tufts or pencils of hairs, the odors at once change in general from a disagreeable to a pleasant nature. In the *Ithomyidi*, Fritz Müller found a pencil or tuft of long hairs near the front margin of the hind wings of the males which emits a distinct and agreeable vanilla-like odor. The same organs with the same odor are occasionally found in some of the females, but the organs are never so large nor the odor so strong. In *Prepona*, one of the *Nymphalinae*, there is a tuft of black hairs on the hind wings of the males which possesses a distinct odor. The same odor of vanilla comes, according to Wood-Mason, from the scent-fans of a species of *Thaumatococcus*, a genus of *Morphinae*, where they are situated in various positions upon the upper surface of the hind wings near the base. Similar tufts of hairs on the wings of the males of a species of *Catopsilia* are said by the same writer to smell like jasmine; while Müller reports that in some of the higher *Hesperidi* he perceived a very faint odor issuing from certain pencils of hairs which are found on the hind tibiae of the males when they were expanding, the pencil being ordinarily hidden in a furrow on the ventral side of the body between the thorax and abdomen. So, too, he found in the males of a species of *Melete*, one of the *Pierinae*, already referred to, a pencil of hairs not retractile, protruding from the ventral side of the tip of the abdomen, which emits "a rather strong odor," but whether agreeable or not he does not state. In addition to these, there are not a few instances known in which the statement regarding the source of the odor is somewhat vague, a gland being referred to when the only specification of such an organ is a collection of scales of peculiar character. On this account and because in certain instances the odor of such collections of scales is plainly due to the scales themselves and not to the pouch in which or the surface upon which they may occur, I prefer to class all these instances in the third group.

This includes odors emitted by scales or clusters of scales. In all instances, so far as known, these are confined to the male sex, the scales themselves or the patches being similarly restricted. Thus we find a spe-

cies of *Antirrhea*, one of the *Satyrinae*, in which, according to Fritz Müller, the males emit a strong odor from a collection of scales on the hind wings at the anterior base of the upper surface, covered by the fore wings and specially protected by a curving mane of pale buff hairs. In a genus of *Morphinae*, *Stichophthalma*, Wood-Mason perceived a pleasant odor emitted by a patch of modified scales and an erectile whisp of hairs on the hind wings of the male. This, he says, comes from a fluid secreted by these scales or hairs, the only instance in which such a secretion has been noted; but this pleasant odor, he adds, is so faint "as barely to be perceptible in the presence of a much stronger odour (resembling that of sable fresh from the furrier's shop*) which is common to the two sexes," but which is not localized. In the neighboring group of *Brasoloniae*, spots of peculiar scales are very often present on the hind wings, and Müller observed that very distinct odors were emitted from these spots in several different genera, particularly in *Dasyophthalma*. So, too, he noted that a rather strong odor was given off from a species of *Ageronia*, one of the *Nymphalinae*, by two large brown spots situated between the wings where they oppose each other, though in other allied species of the same genus neither the odor nor the patch could be detected. A most curious instance is that of the species of *Didonis*, already mentioned, where abdominal glands occur in both sexes and even a second pair in the male, one with agreeable and one with disagreeable odor, a butterfly which is still further beperfumed, since Müller was able to detect a musk-like odor produced by a black spot of scales near the base of the under side of the front wings. Another member of the same subfamily, the European *Charaxes*, is said by Girard to have a strong odor of musk, especially just after its eclosion, though he does not state in which sex it arises or from what point of the body it originates. In our own fauna we have a striking instance of this odor in the scent emitted by the scales clustered along the median nervules of the upper surface of the fore wing in *Argynnis atlantis*, scales which have a distinct odor of sandal-wood, so strong that it is hardly possible to handle living specimens without recognizing it, and which I have known to be retained for many weeks after death, when the insect had been enclosed at capture in a paper envelope. This is the more remarkable because I have never detected the same or any odor in the allied species of *Argynnis* of New England which nevertheless possess precisely the same scales and in the same position. Finally, in this highest family of butterflies, we have the instance of *Anosia plexippus*; the scales found in the little pouch upon the upper surface of the hind wings next the lower median nervule emit a slightly honeyed odor over and above the carroty smell which all the scales possess.

In the next family, the little discal spot of scales upon the upper sur-

* The female of the beetle *Prionus laticollis* is said to have the same odor.

face of the fore wing of the males of a large number of Theclidi are well known, but it has never been noted by any one except Fritz Müller that this patch of scales occasionally has an odor of greater or less distinctness. In the allied group of Lycopseidi, the males of which possess scales of peculiar battledore form scattered over the upper surface of the wings, we find in one of our own species, *Cyaniris pseudargiolus*, an exceedingly delicate odor, which I can only describe as that of newly stirred earth in the spring or of crushed violet stems.

Among the Pierinae, Müller mentions several instances of odoriferous scales, which in some instances are collected into patches and in others not. Thus in *Leptalis* he finds on the portions of the front and hind wings which conceal each other a patch of scales emitting an odor of greater or less strength according to the species, an odor, he remarks, which is "disagreeable to human noses." So, too, in the males of several species of *Callidryas* he discovered in the patch of scales in the same position on the hind wings a musk-like odor of varying degrees of strength according to the species. He adds that our own *Callidryas eubule* emits a faint musk-like odor, but this has been more carefully and independently determined by Miss Murtfeldt of Missouri as a slight violet odor; she was unable, however, to locate the spot from which the odor originated. Again, according to Müller, a "very delicious perfume" is produced on the upper side of the wing of the male of the species of *Melete* already referred to, a perfume which is rather faint but which may be rendered distinct by keeping the animal alive with the wings closed, when the odor may be perceived on opening them. Another instance in which two closely allied species may vary in regard to their odor is found in our species of *Pieris*, the males of *Pieris rapae* being only faintly odorous, while those of *P. oleracea* have a more distinct but still faint odor of syringa blossoms; so, too, *P. napi* of Europe is said by different writers, de Selys Longchamps, Perkins, Weismann, to have the odor of thyme, verbena, orange or balsam. The only one of our Papilioninae in which there are any such scales peculiar to the male sex is *Laertias*, which has the margin of the hind wings reflected, concealing scales of a peculiar character; I have never taken a living male, and so have been unable to detect any odor there, but Edwards speaks of the butterfly as having a strong and disagreeable smell which probably originates here; for Müller has found in other allied swallow-tails odors which arise from exactly this source, the reflected margin being expanded, he says, when the wings are moved strongly in a forward direction, and allowing the odor to escape. Indeed, Müller asserts that in one species there appear to be "two sets of males, emitting equally strong but quite different odors," a case which would be very similar to that of dimorphism in color or markings,—dismorphism we might call it. The odors which he discovered from the different patches of this sort were in some cases agreeable and in some disagreeable.

According to Aurivillius, both male and female of *Oeneis normæ* of Europe have a musky odor, and as he can discover no odor in either sex of *Mancipium brassicae*, a species in which the male possesses large androconia, he looks askant at the so-called scent scales described by Fritz Müller. But if the species of *Oeneis* named possesses this odor in both sexes, it is probable that it does not arise from the scent scales but from some other source, probably from some abdominal excretory organ, such as Müller has described in many other butterflies. I have been unable to detect any odor in three other species of *Oeneis* examined alive by me, and they, like *Mancipium brassicae*, are merely some of many instances in which our senses cannot perceive an odor presumably emitted. Lelièvre, again, found that both sexes of *Thais polyxena* had on eclosion, when handled, an odor similar to that of its food plant *Aristolochia*, the odor arising from a fluid which was left upon the hand that had seized the insect. The European *Papilio machaon* is also said to sometimes exhale a distinct odor of fennel, upon which the larva feeds. All these, however, are plainly means of defence, if they have any purpose, and have no relation to the odors of scent scales. Nor does it appear that any organs for their production have been noted. Among the moths Reichenau records a musky odor in the male of *Sphinx ligustri*, which he traces to a bundle of colorless scales thrust out from either side of the first abdominal segment. Miss Soule says that both sexes of *Samia cynthia* emit a rank odor.

The statement by Müller that the fragrant odors emitted by butterflies are in some cases produced by peculiar scales found in the male sex and which he terms scent scales, was received with a great deal of incredulity, and rightly, because the wing of an insect was looked upon, at least after the butterfly had flown a while, as an almost completely dead organ. But the fact that anyone may experiment with our own butterflies and in several cases prove to himself the exact location of an odor, removes in the first instance any possible doubt as to its origin; and Weismann, in defending Müller, has clearly shown that there *is* a living tissue in the wings of butterflies which would allow of the production of an odor through local active scent glands.

It seems, therefore, to be clearly proved that very many butterflies emit odors either of an agreeable or of a disagreeable nature, and that those which are pleasing to us are in large measure confined to the male sex and are emitted through microscopic canals which course through microscopic scales to microscopic glands at their base within the wing membranes. Now it is quite plain that, since these insects emit odors, they must also be able to perceive them. That this is the case has always been known to be true of moths, since the males of certain species, especially among the Bombycidae, will of an evening enter in great numbers an open room within which a female of the same kind has been disclosed from

its cocoon entirely out of sight of and often at a great distance from her visitors. It is plain that in instances of this sort, known to every entomologist and too numerous to mention, the sense of smell must be the sole directing agent; and since in many of these instances no odor is perceptible to human sense, it is plain that there may be many odors emitted which though imperceptible to us, may be all-sufficient for them. This abundantly explains the many cases of organs from which we can perceive no odor, when in allied insects identical organs are perceptibly fragrant.

Moreover, we have in certain specific structures in the enlarged antennal club of butterflies what are plainly sense-organs supplied with nerve-endings; and inasmuch as there is no structure found in them which could subserve the purpose of hearing, or indeed of any other of the senses known to us excepting that of smell, it is the belief of physiologists that here are situated the organs of smell in butterflies. The under surface of the antennae of butterflies is invariably naked to a greater or less degree, and, more plainly in some joints than in others, little dimples can be readily seen. It is in these little pits that are situated the organs of smell; each consists of a sac-like cavity, the opening into which is often protected by cuticular processes, and at the bottom of which in the hypoderm is situated a fusiform body with a delicate conical ending extended free into the centre of the sac, its other extremity being in direct continuation of a nervous thread.

For myself I am inclined to attribute to butterflies as to moths an exceedingly delicate and high perception of odors. Any one observing their action with this in view will find numerous instances in which this sense certainly seems to come in play, particularly as it appears highly probable from recent researches that the sight of these creatures is far less distinct than was formerly supposed. The mere fact that the eggs of butterflies are invariably laid upon or in close proximity to the food plant of the caterpillar can be explained, it seems so me, only on the supposition that the creatures have the power of distinguishing such plants *by their odors*. If one will watch a butterfly bent upon laying eggs as it flits in and out among the herbage, he cannot fail to perceive the brief visit it makes to plants which seem quite closely to resemble the food plant of the caterpillar, and how quickly it settles upon the desired object as if it were recognized in an instant. More than this, how unerringly it discovers the plant it is in search of even if hidden beneath a canopy of entangled obstacles. It acts in every way as if it were scenting out the object of its quest.

So, too, the very high development of scent scales of varied patterns and character among butterflies indicates a direct sexual use which is the more easily understood when we consider that the greater variety and brilliancy of the colors of butterflies as contrasted with moths has, in all probability, no sexual significance whatever. Brilliant masculine colors may possibly have arisen in birds through sexual selection, but such an origin is impos-

sible in butterflies; since, therefore, the males cannot be attractive to their mates by seductive colors, they resort to odors and vie with each other in the production of sweet-smelling garments.

. Müller's observations are mostly contained in a paper entitled, Notes on Brazilian entomology, in the Transactions of the London entomological society for 1877. A number of instances of odoriferous butterflies are mentioned in a paper by Wood-Mason and de Nicéville on the butterflies of Cachar, in the Journal of the Asiatic Society of Bengal for 1886.

CALLIDRYAS EUBULE.—The cloudless sulphur.

[The cloudless sulphur (Gosse); the danewort butterfly (French); the citron butterfly (Maynard).]

Papilio eubule Linn., Syst. nat., 12th ed., 764 (1767);—Smith-Abl., Lep. Ins. Ga., 1: 9-10, pl. 5 (1797);—Abb., Draw. Ins. Ga. Brit. Mus., vi: 11, figs. 60, 61 (ca. 1800).

Phoebis eubule Hübn., Verz. schmett., 98 (1816).

Collas eubule (pars) God., Encycl. méth., ix: 85, 92 (1819).

Callidryas eubule Boisdu-Lec., Lép. Amér. sept., 74-78, pl. 24, figs. 1-5 (1830);—Boisdu., Spec. gén. Lép., 1, pl. 2, figs. 7, 7, pl. 6, fig. 6 (1836);—Dunc., For. buttl., 122-123, pl. 8, figs. 1-3 (1837);—Poey, Mem. Soc. econ. Hab., (2) ii: 300 (1846);—Lucas, Sagra Hist. nat. de Cuba, 497-498 (1857);—Morr., Syn. Lep. N. Amer., 25 (1862);—Herr.-Schaeff., Schmett. Cuba, 12 (1865);—Butl. (pars), Cat. Fabr. Lep., 222-223 (1869);—Cist. entom., 1: 36, 46, pl. 2, fig. 8 (1870);—Lep. exot., 58, pl. 22, figs. 7-10 (1871);—Seudd., Proc. Bost. soc. nat. hist., xvii: 297-298 (1874);—Murtf., Psyche, iii: 198 (1881);—Edw., Trans. Amer. ent. soc., ix: 9,

12-13 (1881); Pap., iii: 6 (1883);—Aaron, Pap., iv: 172-174 (1884);—French, Butt. east. U. S., 119-120 (1886).

Catopsilia eubule (pars) Kirb., Syn. catal. Lep., 482 (1871);—Gundl., Ent. Cub., 115-117 (1881).

Callidryas eubule Middl., Rep. ins. Ill., x: 78 (1881).

Callidryas eubule Mayn., Butt. N. E., 43, pl. 4, figs. 55, 55a (1886).

Papilio eubule Brown, Butt., 1, pl. 5 (1832).

Callidryas eubule French, Rep. ins. Ill., vii: 147 (1878).

Papilio marcellina Cram., Pap. exot., ii, pl. 163, fig. C [not A, B] (1779).

Collas marcellina (pars) God., Encycl. méth., ix: 85, 92-93 (1819).

Papilio luteus Selig., Samml. ausl. vog., viii, pl. 94 ind. (1773).

Figured also by Glover, Ill. N. A. Lep., pl. 1, fig. 67; pl. 29, figs. 3? 4?; pl. 109, fig. 67; pl. P, fig. 4; pl. R, fig. 13 (ined).

And on the wing, a golden butterfly,
The last, the loveliest, is flitting by.

E D N A D. PROCTOR.—*Indian Summer.*

You will see a fellow,
Scorched by Hell's hyperequatorial climate
Into a kind of a sulphureous yellow.

SHELLEY.

Imago (15: 14, 16). Head covered pretty densely with short, nearly equal, soft slate brown and blackish scale-like hairs, all roseate tipped, clustered to a considerable degree in whorled tufts, which are paired to a certain extent upon opposite sides of the head. On the sides and beneath covered with canary yellow scales, toward the eye becoming tinged with roseate and at the upper posterior border of the eye forming a moderately narrow, roseate edging to it. Palpi canary yellow excepting the portion which can be seen from above, which wholly resembles the upper surface of the head. Antennae covered with pale roseate scales with a few scattered darker ones, nearly devoid of scales and pale luteous along the inner surface; the apical portions of the club partially denuded and then dull, yellowish luteous. Tongue luteo-fuscous for a considerable distance at base and also at tip, the middle blackish fuscous.

Prothorax covered with rather short soft greenish slate brown, scaly hairs. Rest

of thorax covered above with long, pale greenish yellow hairs, on the posterior portion more yellowish, anteriorly gradually becoming strongly tinged with brown; patagia like the anterior portion, but their outer edge and posterior tip yellowish; thorax beneath covered with short, uniformly yellow hairs and scales. Legs nearly uniform, dull, pale luteous; coxae tufted beneath with yellow hairs, which are paler on the posterior than on the anterior surface; the femora covered with pale canary yellow scales, the anterior surface of the hind pair often with a broad stripe of lemon yellow scales; tibiae and tarsti sprinkled with very pale yellowish scales; tibial spurs pale, tipped with reddish brown; spines dirty pale; claws varying from fuscous to dusky brown, pale at base; paronychiae pale, often fuscous at tip; pad pale fuscous.

Wings above uniform, bright canary yellow, a very little brighter in the ♂ than in the ♀, the costal border of the hind wings, as far as the subcostal nervule, except in the apical half of the wing, paler. In the ♂, the upper surface of the wings is entirely without spots, excepting that the extreme tips of the nervules not infrequently have an inconspicuous brown dot, especially upon the fore wings; and the costal border of the fore wings is delicately edged in front, but not above, with lilac brown; The wings are also sufficiently diaphanous to show the spots on the middle of the wings beneath. There is a bordering of raised scales on the upper surface of the wings of the ♂; on the fore wings (44: 5, 6) it occupies the whole of all the subcostal interspaces but the lowest, but without reaching the nervures, especially at the base of the interspaces; along the middle of the lower subcostal interspace it reaches two-thirds the distance to the base of the interspace, and forms a very greatly produced triangle; below this in each interspace to the submedian interspace is a series of arched spots reaching from one to two interspaces' width inward but connected only at the extreme edge of the wing; a rather narrow band follows the inner border from the tip of the submedian nervure two-fifths the distance to the base of the wing; on the hind wings it forms a narrow, nearly equal border from the costal nervule almost to the lowest median nervule, less than half an interspace in width. In the ♀, besides the front edging of the costal border, the fore wings have the apical fourth of the same border edged to a greater or less extent but always rather narrowly and usually interruptedly with dark brown, having a maroon tinge; the same color but often having a pinkish hue occurs in distinct roundish spots at the extremity of all the nervures, terminating on the outer border, usually occupying a little less than the width of an interspace, but occasionally almost commingling to form a border, uniting with that at extremity of costal margin, which in this case is more than usually pronounced; the spot at tip of submedian is always smaller and more obscure than the others; the outer border is very narrowly edged with pinkish and at the extremity of the discoidal cell is a large, irregular, but roundish, dark brown spot, occupying almost the entire width of the base of the subcosto-median interspace, never reaching the median but sometimes crossing the lower subcostal nervule; its middle or the middle of its inner two-thirds is traversed by the vein closing the cell, which is either simply defined by orange scales or becomes the nucleus around which, nearly in the centre of the brown spot, a pretty large pupil of mingled yellow and pinkish orange scales is formed. The hind wings agree with those of the ♂ except in having the spots at tip of veins a little, sometimes considerably, larger and the outer border delicately and faintly edged with pink. The short fringe of all the wings in the ♂ is pale, partially covered at base and sparingly flecked at tip with blackish brown, excepting below the lower median of fore wings and above the middle subcostal of hind wings where it is generally yellowish; at the tips of most of the nervures it is wholly brown; in the ♀ it is essentially as in the ♂, only partaking to some degree, especially at the base, of the pinkish tinge of the edging of the wing and in having a little greater proportion of dark scales.

Beneath of a duller, frequently more greenish and less pure color, the whole surface being very distantly flecked to a greater or less extent with pinkish brown atoms, although occasionally, in the ♂, these are exceedingly rare or entirely wanting, in which case the color is nearly as brilliant as above and the wings have no spots what-

ever; they are always wanting on that part of the fore wing which is covered by the hind pair when the wings are naturally expanded; towards the base very many short, curved, yellowish, delicate hairs. *Fore wings*: at the extremity of the discoidal cell is a transverse, compound spot, conspicuous in the ♀, not infrequently reduced to a dash in the ♂, consisting normally of two confluent spots, the upper and smaller traversed by the transverse portion of the lowest subcostal nervure and equalling the base of the lowest subcostal interspace in width, the larger bearing the same relation to the vein closing the cell and the subcosto-median interspace; the nervules and even the creases of the wing frequently break these up into smaller spots but these relations are never wholly obscured; the spots are of a salmon brown (usually in the ♂), or pinkish brown (usually in ♀), the centre more or less enlivened with silvery (usually in ♂) or dull silvery (usually in ♀) scales and the whole edged rather broadly (especially in ♀) with dark brown scales, although the brighter brown scales of the interior of the spot not infrequently pass this barrier, especially exteriorly. The other spots of the wing which are, however, occasionally obsolete wholly or in part, consist of a clustering or of clusterings of sprinkled pinkish and blackish brown scales into a strongly sinuous series of spots and wavy transverse bars crossing the middle of the outer half of the wing; it consists of two portions: the upper, above the median nervure, forms a very strongly bowed or arched series of markings starting from a roundish spot in the upper subcostal interspace a little within the last branching of the subcostal, and extending nearly subparallel to the costal and outer border to a tremulous, transverse, oblique, vague dash in the middle of the subcosto-median interspace; the markings in the upper three interspaces are all similar and equidistant, the last being in the middle of the interspace contained between the terminal forks of the subcostal; those in the three lower interspaces are also similar to one another and from a nearly continuous broken line; the lower portion of this series consists of markings in the median interspaces similar to, but less oblique than, those in the lower subcostal interspaces subparallel to the outer border and distant from it by a space equal to about one and a half interspaces; costal margin very narrowly edged with pink and the outer margin a little more broadly, and in ♀ more broadly than in ♂, with salmon color, the extreme tips of the nervules dotted with black. *Hind wings* with four subparallel, equidistant, transverse series of ill-defined spots and transverse bars and streaks of mingled salmon colored and blackish brown scales, not infrequently partially and sometimes (in ♂) almost wholly obsolete; the basal series consists of three small round spots, one covering the base of the united nervures, one just without the costal, midway between its divarication from the subcostal and the origin of the precostal, the third above the costal, a little further beyond the precostal; the second series consists of a transverse streak in the costo-subcostal interspace, midway between the precostal and tip of costal, and next of a row of equidistant small spots often vaguely connected into a streak, running in continuity with the base of the upper subcostal nervule from the middle of the upper half of the cell to the internal nervure; the third or mesial series consists first, of a more extensive streak, rather broad in the middle of the wing in the ♀, extending from a little beyond the middle of the upper subcostal nervule to the second divarication of the median nervure, and enclosing the outer half of two slightly unequal roundish oval, silver spots, encircled with blackish scales on a salmon base; the upper is generally the smaller and rounder and longitudinal, placed in the lower subcostal interspace at a little more than an interspace's distance from its extreme base; the other usually follows nearly the direction of the upper half of the vein closing the cell which traverses its middle; below the cell, this mesial stripe consists of a usually interrupted V-shaped streak in the medio-submedian and submedio-internal interspaces, starting next the lower median just below the last divarication of the median in the same direction as the upper portion of the mesial series; it reaches only as far as the middle of the interspace and is then bent sharply baseward; the fourth or outer series is usually rather indistinct; it crosses the middle of the outer half of the wing and consists of a series of transverse, sinuous, disconnected

streaks in the interspaces between the middle subcostal and lower median nervules; in the lower subcostal it lies midway between the mesial series and the outer border of the wing; in the subcosto-median it is considerably nearer the former; below this it is about in the middle of the interspaces it occupies; the outer edge of the wing is as in the fore wings except in not being so broadly edged with pink in the ♀ as there. Fringe of both wings ashy pale, often somewhat intermingled with brownish black, especially on the apical half and sometimes with the base partly covered with pink scales.

Abdomen yellow above, black at extreme base where it is covered with long, greenish hairs and often along a not very narrow dorsal line; beneath yellowish white. Prolongation of eighth abdominal segment of the male (35: 1, 2) making the upper surface of this segment nearly equal in length to the three preceding taken together, reaching backward to the tip of the clasp. Hook of upper organ slender but deep, the inferior edge broadly but roundly excised before the pointed tip. Clasp twice as long as broad, the upper tooth larger than the posterior and curving much more strongly inwards; interior finger expanding as it curves inward and backward, but appressed, the prickles slightly larger at their distal extremity and as long as the breadth of the finger.

Measurements in millimetres. Length of tongue, 26.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	30.5	33.75	38.5	29.	35.5	37.
antennae.....	12.75	13.5	15.	10.75	13.2	13.75
hind tibiae.....	9.2	10.5	11.75	8.6	10.5	11.
fore tibiae and tarsi.....	6.1	6.1	7.	4.8	6.1	6.75

Described from 15♂, 13♀.

Specimens from Cuba are smaller than those from Florida and Texas.

Accessory sexual characteristics. The mealy bordering to the upper surface of the wings found only in the male (44: 5-6) has been described above. Specimens collected in Florida agree in general with those from the northernmost point at which the species has been taken abundantly (Long Island, N. Y.), in having a slender extension of this band along the inner border nearly to its middle, narrowing as it passes toward the base; in all the subcostal interspaces the patches (always separated from each other by the nervures) often extend almost to their very base, leaving but a narrow, free space between the patches and the nervures; this is especially the case in those interspaces which open upon the costal margin; in the lowest subcostal interspace the patch almost invariably extends half-way to the cell, sometimes close up to it.

The scales which occur here (46: 33) differ from those about them in their triangular form, coarser striation, well rounded and entire apical margin, and, what gives them doubtless their peculiar appearance, their slight elevation, as is shown in pl. 44, fig. 6. Apparently, however, these scales have no perceptible odor; this is not the case, according to Müller, with the scales (46: 32) found in what might be termed the Rhodoceriid patch, at the extreme base of the costal border of the hind wings, above, where the scales are of a more delicate shape, more regularly long-oval, but with precisely similar striation and texture; both are to be regarded as androconia. Hagen says the latter patch is only present in specimens from Florida and not in those from Texas, but I suspect the scales will be found alike in all.

Egg (65: 30). Broadest in the middle where it is very broadly rounded, the curve scarcely increasing toward the apex, which is truncate and about an eighth as broad as the middle, and rapidly increasing at the extreme base where it is broadly rounded and less than one-third the diameter of the middle. Longitudinal ribs about seventeen in number in the middle, where they are .1 mm. apart, very thin, sharp, slightly elevated and straight; the transverse lines which break the interspaces into cells average in the middle of the egg rather more than twice as broad as long and are about .08 mm. in distance apart, broader and less sharply defined than the vertical ribs and apparently impressed; the surface is entirely smooth and the color a uniform yellow.

Height of egg, 1.1 mm.; breadth at summit, .07 mm.; in middle, .56 mm.; at broadest part of base, .2 mm. Described from a specimen mounted on a slide received from C. V. Riley.

Caterpillar. *Last stage* (76: 2, 4). Head (79: 67) and body of a pale green with a bluish or olivaceous tint, particularly on the body above. The head is variegated by the blackness of the larger tubercles and the front row of ocelli; mouth parts testaceous. Body ornamented by a bright yellow stigmatal band which extends its whole length and is sometimes edged with a clearer tint and deepens to orange apically, and besides is made more conspicuous by breaking in two unequal parts what would otherwise be a large, stigmatal, dark blue or bluish black spot on the middle of each segment from the second thoracic to the seventh or eighth abdominal; this spot is better developed above than below the stigmatal band, is made up of more or less confluent transverse stripes and is deepest in color on such larger tubercles as it embraces; the other larger tubercles of the body are black, sometimes surrounded at base with sky-blue. The under surface is yellowish green, paler along the middle. The stigmata are white and are situated in the lower half of the yellow band. The legs and prolegs are yellowish, the claws reddish. Length, 40-45 mm.; breadth, about 5 mm.; breadth of head, 2.75 mm.

The plate represents the yellow band as too obscure. Described from blown specimens, aided by different colored drawings and by notes of Dr. Juan Gundlach.

Chrysalis (84: 60-62). Generally of a pale glaucous green with yellow stripes; sometimes pale yellowish green; sometimes roseate, minutely dotted dorsally with yellow; sometimes pale green, dotted similarly with pale and testaceous points. The antennal sheaths forming the margin of the anterior ridge are usually yellow and the whole lateral ridge from the antennae to the cremaster is distinctly though narrowly marked with yellow, as are often all the veins of the wings. The dorsal line is further marked, but generally less distinctly and much more broadly, with yellow sometimes edged with white; or it may be dull green edged on the abdomen with yellow; the wings are sometimes flecked with brown. The spiracles are pale testaceous; the minute raised points on the ventral side of the cremaster and the cremastral hooks are fuscous. Length in a direct line, 30 mm.; the same following the middle line of the body, 31.5 mm.; length of frontal tubercle beyond front of eye, 6.5 mm.; breadth at shoulders, 6.2 mm.; depth at middle of body, 12.5 mm.; breadth of wing cases, 11 mm.

Described from alcoholic specimens received from Dr. Riley, aided by drawings of Judge Chapman and notes by him and Dr. Gundlach.

(**Distribution 25: 5**). This butterfly belongs to the Carolinian fauna, but spreads far beyond both to the north and south. It extends down the Atlantic coast to the Florida Keys (Palmer) and along the Gulf coast to Texas (Belfrage), and is found also in New Mexico (Snow), Arizona, where a variety was found at a height of ten thousand feet on Mount Graham (Morrison), and southern California (H. Edwards). South of the United States I have seen specimens from Mexico (Sallé, Palmer), Guatemala (Van Patten), Tehuantepec (Sumichrast) and Cuba (Gundlach, Seudder); it is also said to occur in Jamaica, Porto Rico and Antigua (Gundlach) and is credited to Brazil and the Argentine Republic, and even to Patagonia (Berg). It sometimes occurs in considerable abundance in the southern half of the Alleghanian fauna and even invades the northern half, having been reported from West Virginia "occasional" (Edwards), Maryland "rare" (Uhler), Philadelphia "very rare" (Blake), eastern Kansas "rare" (Snow), Iowa (Edwards), Wisconsin (Hoy),

southern Illinois "sparingly" (French), northern Illinois (Worthington), Dayton and Columbus "occasionally" and at Cincinnati, Ohio, in great numbers (Kirtland), though Dury says it is rare at the latter point; Bergen Hill (Akhurst, Andrews) and Brigantine Beach, N. J. (Hamilton); New York City (Smith), Fire Island Beach "abundant" (Smith), Babylon "few" (Smith) and other parts of Long Island (Akhurst, Hooper, DeForest, Tepper).

In New England proper it has only been found in the following places on the southern coast, mostly near Narragansett Bay: Narragansett Pier, South Kingston "very abundant" (Chapin), Newport, R. I. (McCurdy), New Bedford (Parker) and Fall River, Mass. (McCullum), and New Haven, Conn. (Yale coll. mus.). It is the only case known of a southern butterfly with a widespread distribution which has invaded the southern coast of New England and has not been detected in southern Ontario. This is the more remarkable as it is found in Wisconsin, sometimes in considerable numbers, at a much higher latitude than in Ohio.

Oviposition. Dr. C. V. Riley once observed the female ovipositing, and tells me that she laid about one egg a minute in the twenty minutes she was watched. She chose the more tender leaves of the food plant and laid them both upon the upper and under surface of the leaflets.

Food plants. The caterpillar feeds on different species of *Cassia* (Leguminosae); Abbot and Smith figure it on *C. marylandica* Linn., on which Riley observed it; Boisduval and LeConte specify *C. chamaecrista* Linn., and Dr. Chapman has taken it upon the latter and upon *C. occidentalis* Linn. and *C. tora* Linn. Dr. Gundlach states that in Cuba it feeds also on "other *Caesalpinieae*." Mr. Lintner says it will feed upon clover, and a chrysalis was sent Mr. Riley, found on cabbage, upon which, however, it is hardly probable that the caterpillar had fed.

Life history. It is probably double brooded, both in the north and south; the second brood is much more abundant than the first, and the imago being long lived, some individuals, at least, probably hibernate; in Florida, according to Dr. Chapman, they are upon the wing from the middle of February until almost the end of November, and the observations of Palmer and Schwarz agree with this. In the south the first brood of fresh butterflies makes its appearance the last week of April, and the second early in August or even by the 21st of July, and continues in multiplied numbers throughout August and September. The eggs are laid at least until the middle of September; the chrysalis state at this season lasts ten or twelve days,* and as Abbot records one butterfly as emerging early in October, and Dr. Oenler sent me fresh butterflies as late as the middle of November, from Wilmington Isl., Ga., it doubtless

*According to Abbot; Dr. Gundlach says that it continues eighteen days in Cuba; perhaps his observations were made on the earlier brood.

hibernates either as a caterpillar or a butterfly; the same is probably true in the north, where the spring brood is unknown, although doubtless existing, and the autumn brood appears in the latter part of August.

Habits of the butterfly. The butterfly is very fond of flowers; Gosse, writing from Alabama, says: (Letters, 38) "having gathered a spike [of *Caprifolium sempervirens*—scarlet woodbine] it was visited, even while in my hand, by a fine yellow butterfly (*Colias eubule* Boisd.), which instantly began probing the deep, tubular blossoms with its sucker; so eager was it to gratify its appetite, that without any trouble I caught it in my fingers." Mr. Chapin found it in Rhode Island, flying about cardinal flowers. It is seen only in the blazing sunshine.

The male has a fragrant odor, which Miss Murtfeldt likens to that of violets, but Fritz Müller, who says it comes from the spot at the base of the hind wings above, covered by the fore wings, calls musk-like; according to Miss Murtfeldt, it is retained several days after capture. It "flies very swift," according to Abbot, but Maynard says it moves "from flower to flower with a leisurely, well sustained flight, occasionally moving rapidly from place to place."

Its congregating habits and migrations. All southern observers have borne witness to the great numbers in which this showy butterfly congregates, and instances of its migrating in flocks are not unknown. Thus the veteran naturalist, Prof. Lewis R. Gibbes, writes from Charleston, S. C. (Can. ent., xii: 60):—

In the course of the last two or three years several accounts have appeared in Nature of flights of Lepidoptera in large numbers. I observed a similar phenomenon in 1870, which may present sufficient interest to be put on record. In the summer of that year, in the month of August as well as I remember, I was crossing the harbor of this city in the 3 p. m. trip of the steam packet boat between the city and Moultrieville, on Sullivan's Island, at the entrance of the harbor, a summer resort of the inhabitants of our city. The distance is between four and five miles, and when about half way or perhaps two-thirds, the steamer passed through an immense stream of butterflies crossing the harbor toward the southwest. They were all of the genus *Callidryas*. . . . The wind was light, and from the rapid motion of the vessel it was difficult to say whether the insects were aided or opposed by it in their transit. As the vessel passed obliquely through the stream, their rate of motion could not be determined, and the dimensions of the stream only roughly estimated; it seemed to be six or eight yards wide, about as many high, and extended an hundred yards or more on each side of the vessel. Whence they came or whither they went could not be ascertained; they seemed to be crossing the harbor in a direction nearly parallel to the general travel of the coast.

Prof. J. E. Willett of Macon, Ga., writes to the same journal at almost the same time (xii: 40):—

I saw *Callidryas eubule* passing here in great numbers during September, October and November, 1878, from northwest to southeast. About noon, when they were most abundant, there would be half a dozen visible all the time, crossing a 15-acre square of the city. They pursued an undeviating course, flying over and not around houses and other obstructions. They flew near the ground, and stopped occasionally to sip

at conspicuous flowers. A geranium with scarlet flowers, and set in the open yard, attracted most that flew near it. Papers in southern Georgia noticed the great numbers passing at different points; and a friend in southern Alabama sent me specimens of the same, saying that they were subjects of speculation there. About March, 1879, there was a similar migration from southeast to northwest, but in diminished numbers. I saw the fall migrations again October and November, 1879, but in smaller numbers than in 1878. A lady of southern Georgia told me that her husband called her attention to the fall migration twenty-six years ago, and that she had observed it every year since. *C. eubule* is found here in small numbers at other seasons of the year.

The same phenomenon has been witnessed further north; thus Hamilton, writing of the New Jersey coast (*Ibid*, xvii: 204), says:—

Specimens were observed on the wing nearly every day along the margin of the ocean, flying apparently at the height of fifteen or twenty feet, and about the same distance from the shore, so that their capture could not be effected, though I took a crippled one and thus ascertained the species. All appeared to be southward bound, flying steadily but slowly.

So, too, at the northernmost point at which they have been found, at Narragansett Pier, R. I., Howard L. Clark says that in 1869 or 1870 (*Rand. Notes nat. hist.*, i; No. 5, p. 8):—

They led me along the shore road toward the north pier, and thence to a rough, marshy meadow, back of the beach, and here I truly had glorious sport. The eubule were swarming about the brilliant cardinal flowers, which grew in abundance, and their numbers were constantly augmented by new arrivals, which all appeared to come from the south. Most of the specimens were considerably mutilated, and appeared to have been on the wing for a considerable time. I obtained, however, some two dozen fair specimens and some nearly perfect. They were common about the place for several days and then gradually disappeared.

Desiderata. The duration of the egg of this butterfly is unknown, the structure of the young larva undescribed, and the history of the chrysalis rests upon few observations. All points in the life of the insect, and especially the condition in which it survives the winter, need investigation; the duration of the autumn brood in the north has not been studied, no earlier generation has been observed, and the postures of the butterfly and habits of the caterpillar remain undescribed. Most doubtful in the account above, and needing verification, is the number of broods in the south.

LIST OF ILLUSTRATIONS.—*CALLIDRYAS EUBULE*.

<i>General.</i>		<i>Imago.</i>	
Pl. 25, fig. 5.	Distribution in North America.	Pl. 15, fig. 14.	Male, both surfaces.
	<i>Egg.</i>	16.	Female, both surfaces.
Pl. 65, fig. 30.	Plain.	35: 1, 2.	Male abdominal appendages.
	<i>Caterpillar.</i>	40: 2.	Neuration.
Pl. 76, figs. 2, 4.	Full grown caterpillars.	41: 5, 6.	Patch of raised scales.
79: 67.	Head, fifth stage.	46: 32, 33.	Androconia.
	<i>Chrysalis.</i>	56: 1.	Side view with head and appendages enlarged, and details of the structure of the legs.
Pl. 84, fig. 60.	Side view.		
61, 62.	Outline views.		

XANTHIDIA BOISDUVAL AND LECONTE.

Xanthidia Boisduval, Lép. Amér. sept., 48 (1829-30). *Abacis* (pars) Hübn., Verz. bek. schmett., 97 (1816).

Terias (pars) Auctorum.

Type.—*Papilio nicippe* Cram.

My idle fancies stray,
Even as these noiseless yellow butterflies,
That poise on grass or flower, and drift away
Like wavering leaves in their perpetual play.

STORY.—*Under the Heres.*

Imago (56:4). Head rather large, covered with very short, scale-like, erect hairs, much longer and somewhat triangularly tufted on the front. Front rather largely and regularly tumid, but to a greater degree below, falling off rather rapidly at the sides, flattened slightly down the whole middle of the front, but surpassing considerably the front of the eyes; above with a slight sulcation in front of each antenna, and with the sides of that portion lying between the antennae sloping considerably to either side, forming a median ridge, somewhat higher than broad, about three-quarters as broad as the front view of the eyes, the sides diverging a little upward; upper margin sloping a little toward the antennae; lower margin very broadly rounded. Vertex largely and rather uniformly tumid, rising considerably above the level of the eyes, the scarcely projecting anterior angles rather largely depressed, but a little raised at the extremity, the front border elevated, squarely cut at the sides, a little rounded off in the middle. Eyes rather large, not very full, naked. Antennae inserted very slightly in advance of the middle of the summit, in distinct, not very deep pits, open toward the eyes, separated from each other by the width of one of the pits; considerably shorter than the abdomen, composed of thirty-six joints of which ten or eleven form a strongly compressed club (87:8), four times as broad as the stalk, about four times as long as broad, obovate, increasing rather rapidly and regularly in size up to the antepenultimate joint, the tip strongly rounded; down the middle of the under surface, occupying the whole breadth of each joint is a row of circular shallow depressions. Palpi short, stout, much compressed, considerably longer than the eye, the last joint minute, scarcely more than a third as long as the middle, which is itself less than half as long as the basal joint; all furnished abundantly with large scales which project considerably beyond the margin of the under surface, all strongly compressed in a vertical plane.

Prothoracic lobes minute, semioval, half as broad again as long or high, tumid. Patagia rather small, broad and long, a little arched, flat, not more than three times as long as broad, well rounded at the base, both borders nearly straight; tapering rather regularly and very gradually, it is scarcely less than half as broad at tip as at base and well rounded at the apex.

Fore wings (40:9) fully two-thirds as long again as broad; the costal border somewhat and rather regularly convex, but rather more so next the base, the outer angle rather abrupt but rounded off; outer margin very broadly rounded, flattened along the middle half, its general course at an angle of about 70° with the middle of the costal border; inner border a little sinuous, convex in the middle of the basal half, concave beyond, the outer border rounded off. Costal nervure terminating at the middle of the costal border; subcostal nervure with three branches, the first arising before the middle of the outer two-thirds of the cell, the second at the apex of the cell, and the third nearly as far beyond as the first is in advance of it, the upper branch forking at a similar distance from its base; cell considerably less than half as long as the wing and three times as long as broad.

Hind wings with the costal border considerably and roundly expanded near the base, beyond slightly and regularly convex; outer border rather strongly rounded and pretty regularly, except a slight rounded excision in the medio-submedian, and the

lower half of the lower median interspaces; it is, however, more prominent in the subcostal region in the ♂ than in the ♀; inner border very strongly and very abruptly expanded at the base, beyond scarcely convex, the outer angle scarcely rounded off. Costal nervure destitute of a precostal branch; vein closing the cell bent at a strong angle near the middle, striking both subcostal and median nervures at equal distances beyond their second divarication.

Fore tibiae more than three-fifths the length of the middle tibiae; fore tarsi slightly longer than the fore femora, about four-fifths the length of the middle tarsi and scarcely three-fourths that of the hind tarsi; hind femora two-thirds the length of the middle pair in both sexes. Tibiae rather abundantly supplied with very short and very slender spines over the whole of its surface, the apex with rather long and slender tapering spurs. First joint of tarsi scarcely equalling the others combined, the second but little longer than the third and the fifth but little longer than the fourth; furnished very abundantly on all sides with short and very slender, delicate spines, arranged in longitudinal rows, four of which are on the under surface; an apical pair on each joint are much longer than the others; claws small, slender, compressed, divaricating moderately, rather strongly curved, bent a little in the middle, bifid for about half their length, the lower branch a very little shorter, both finely pointed; paronychial simple, consisting of a rather broad, elongate lobe outside of and partially concealing the claws, nearly equal, straight, tapering toward the tip, nearly as long as and reaching the point of the claw; pulvillus nearly circular, small, on a rather stout, cylindrical pedicel, half as long as the claw and constricted at the apex.

Eighth abdominal segment of male apically prolonged into a compressed, hood-shaped expansion above, half as long as the body of the segment. Upper organ with a moderately large centrum but a very small, cylindrical, tapering, pointed hook, curving a little downward on its apical half, the extremity of the centrum bearing a considerable, inferior, compressed expansion, the form of which should be studied from living specimens. Claspers subquadrate, but tapering, a little convex, but hollowed in the middle of the basal half, the edges greatly thickened, incurved and bearing, near the upper posterior angle of the clasp, several pretty stout, incurved, laminate teeth.

Egg. Fusiform, about three and a half times longer than broad, largest just below the middle, regularly tapering above to a very narrow summit and rounded, roundly tapering below to a broader but very narrow and truncate base. Vertical ribs numerous, sharp, but very little elevated, not infrequently furcate; transverse lines very slight and not sharp. (From alcoholic specimens.)

The shape is badly given in the plate and the cross striae are not shown (65: 31).

Mature caterpillar. Head well rounded, of equal breadth and height, scarcely narrower than the segment behind it, truncate below; considerably compressed, of subequal depth excepting above; the triangle reaching nearly the middle of the upper half of the head; surface sparsely provided with small but high conical tubercles, each emitting a rather short, forward curving hair. Ocelli six in number, the anterior four in a scarcely arcuate row, the upper three subequidistant, the fourth a little further removed, the fifth and sixth in a row parallel to these, respectively behind the first and third.

Body slender, cylindrical, tapering distinctly from the middle of the thoracic segments forward and from the sixth abdominal segment backward; abdominal segments subdivided into six subsegments, of which the second is the largest; the thoracic segments with a less number; covered rather sparsely with small, equal, blunt, conical papillae, nearly twice as high as broad, arranged in transverse rows, one to each subsegment; otherwise the papillae are irregularly distributed, except that they are most abundant in the dorsal and suprastigmatal fields and only appear below the stigmata in infrastigmatal patches in the middle of the segments; these papillae support short, slightly curved, equal, bulbous-tipped hairs, among which are a very few of twice the length of the others; spiracles rather long, obovate. Legs moderately stout, rapidly tapering, the basal joints particularly large, the front pair scarcely half so large as the others; hooks minute, slender, curved. Prolegs short and stout. First thoracic seg-

ment beneath with exceedingly large and broad mammillate protuberances deeply sulcated longitudinally in the middle.

Chrysalis. Of the general form of *Callidryas* but with less protuberant wing cases, straighter form and shorter frontal prominence; the general outline of the dorsum is nearly straight, the head and frontal prominence being in nearly the same line with the abdomen, but the abdomen has a very broad arcuate sweep, while the line of the head and frontal prominence is almost straight. The thoracic curve is also gentle as in *Callidryas*; the projection beneath, formed by the wing cases, is very great, their outline being strongly arcuate, at their extreme forming an arc of a circle whose opposite arc would scarcely reach the dorsum of the first abdominal segment. Seen from above the form of the chrysalis is very slender, slightly broadest at the middle of the thorax, in front of which the head and frontal projection have an almost uniform conical shape, reaching almost to a point; at the hinder edge of the wings, the body is swollen, but almost imperceptibly, and beyond it the abdomen tapers with great regularity to the truncate cremaster; frontal projection regular, conical; prothoracic stigmata with no visible opening; tongue small, surpassing the tips of the antennae and reaching almost or quite to the height of the strongest curve of the wing cases. A well-marked carina runs backward close to the inner margin of the upper wing, becoming obscure the moment it passes its limits and beyond that becoming a small, scarcely perceptible, stigmatal ridge to the lower lateral angle of the cremaster, just before reaching which it again becomes distinct; so, in front of the basal wing tubercle, there is a slight indication of its presence in a low, broad, scarcely perceptible ridge, running to the base of the frontal projection. The thoracic dorsal elevation is also slightly compressed and follows as a blunt, low ridge to the cremaster, forming along the crest a fine mediodorsal sulcation on the thorax. Surface obscurely verniculate. Cremaster tetraquetral, broader below than above, all the sides broadly sulcate, but especially beneath, where it is also provided apically with a deep medioventral sulcation, of which there are faint indications also upon the segments in advance of it and especially upon the eighth. The truncate extremity of the cremaster is strongly transverse. Hooklets not very large, with a slender stalk which tapers from apex to base, and is crowned with a very large, almost hemispherical, reversed cup, three or four times as broad as the base of the stalk.

This American genus is composed of a single species, which extends east of the Rocky Mountains from the middle of the Alleghanian fauna to Guatemala and perhaps to Brazil, including at least some of the larger Antilles.

The butterflies are medium sized Pierinae and may be distinguished from others with rounded wings, by the form of the dark border of the fore wings, which is confined to the upper surface and conspicuously contrasted with the deep orange disk; this border starts a little beyond the middle of the costal edge and runs toward the middle of the outer margin, then turns, forming a broad outer border, extending, in the male, to the inner margin; there is a similar broad border on the hind wings of the male, but in the female this only appears on the upper half. The under surface is much paler, especially that of the hind wings, which is flecked as in *Eurema*.

The single species is probably double brooded, wintering in the imago state and appearing fresh in May and August.

Dr. Gundlach states that the flight of the butterflies is rapid, continuous and unvaried. They frequently alight on flowers and, like many *Rhodo-*

ceridi, congregate in damp spots. The larvae feed on leguminous plants, especially on *Cassia*.

The eggs are described as fusiform, more strongly so than in *Eurymus* with very numerous ribs.

The caterpillars are greenish gray with a pale stigmatal band and frequent short hairs mounted on conical tubercles, much more prominent, especially on the head and thoracic segments, than those of *Eurymus*, which genus in general the caterpillars resemble.

The chrysalids somewhat resemble those of *Callidryas*, having greatly protuberant wing cases, a long, conical, frontal prominence bent slightly upward, and on the thorax a slightly arched and compressed dorsal crest. They are green with numerous small, scattered, black spots and a pallid line along the whole side of the body.

EXCURSUS XLI.—THE COLONIZATION OF NEW ENGLAND.

Trembling with joy awhile she stood,
And felt the sun's enlivening ray;
Drank from the skies the vital flood,
And wondered at her plumage gay!
And balanced oft her brodered wings,
Through fields of air prepared to sail:
Then on her vent'rous journey springs,
And floats along the rising gale.

The Butterfly's Birthday.

WHEN discussing in a former excursus the butterflies common to the Old and New Worlds, we pointed out how much closer was the relationship between the butterflies of the two hemispheres in the high north than in the northern temperate zone. If we could go back in time to the warmer tertiary periods, we should no doubt, in these same regions, find a complete or nearly complete unity of type between the butterflies of this hemisphere and of the Old World. At the present time, as we go farther and farther south toward the tropics, the distinction between the assemblages in the two worlds becomes greater and greater, until in the tropics themselves we probably should find scarcely a genus identical in the two hemispheres, and not infrequently whole tribes peculiar to one or the other world. It will be evident from this that some parts at least of the present butterfly fauna of New England find their nearest allies in the north; indeed a few of the species belong more properly to the subarctic regions than they do to New England itself. And if we were to judge of the derivation of the present fauna of New England by the geographical distribution of its members and of their nearest allies we should discover that the facts which this method of investigation yields (and it seems to be a fair method) entirely agreed with the demands of the geologists that we should regard a recent condition of New England to have been one of complete submergence under ice and snow, a condition of things forbidding its being the home of any butterflies whatsoever.

If, now, we were to draw a picture of the series of events which followed the great glacial epoch, we should see the ice receding by slow but continued steps, followed closely by the plants which can bear the cold, and these by the creatures which feed upon them, until at last the region becomes completely re-populated. As the cold diminished and the seasons improved, we should gradually reach the condition of things that we find at the present day, viz., in the northern and higher, cooler parts, relics of those forms which can endure the cold; in the heart of the region a great body of forms, which, considering the long continuance of its present condition, may be deemed in a limited sense endemic; and the existence along the southern border of more southern forms, striving to gain and maintain a foothold.

If we analyze the generic types which exist at the present day in New England, we shall find that the other representatives or the nearest allies of about one-half of them belong to the region lying to the south; the bulk of the remainder would be those whose other members occur in other parts of the north temperate zone, whether in America or in the Old World; a few would be found restricted otherwise to the region lying to the north, and a few others again, peculiar to North America, would find their other representatives only in the region lying to the west. One or two types also may be considered as cosmopolitan, *Vanessa* in particular; while *Hypatus* belongs to a cosmopolitan or vagrant group, having scattered members, closely allied, in nearly all parts of the world. There would remain, however, two or three genera, the presence of which would be somewhat difficult to account for. One is *Anosia*; the difficulty here does not arise from its presence in New England so much as in America, since with a few other types, like it distributed throughout the tropics of America, it belongs strictly to the Old World division of the family, the great body of its relatives, which are very numerous, being found in the tropics of the Old World. The presence of two other genera, *Enodia* among the satyrids and *Feniseca* among the coppers, is still less easily understood. Their nearest allies are all found south of the tropics in the Old World and the explanation of their presence, not only in the New World but exclusively in the regions north of the tropics, is the puzzle. They alone can be mentioned as widely separated in structure from their immediate allies in North America and as endemic types of probably great antiquity. There are, however, other genera which are of similar though secondary interest, since, though not peculiar to New England certainly but to the north temperate zone of North America, they are somewhat widely separated from their neighbors structurally. Such, among the Nymphalidae, are the genera *Satyrodes*, *Speyeria* and *Euphydryas*; among the Lycaenidae, the genus *Strymon*; among the Papilionidae, *Jasoniades*; and among the Hesperidae, *Poanes* and *Polites*. Of these it should be remarked that all but *Euphydryas* find their nearest

affinities in the south, principally in Mexico and Central America; while *Euphydryas* is more nearly allied to other *Melitacidi* in the north temperate zone.

So one might proceed from the essentially peculiar to those which were less specialized from their neighbors until the species were reached. All, however, would tell the same story,—The existence before the glacial epoch of a free communication between the north temperate zone of the two worlds; of the subsequent invasion of this zone by the cold, pushing animal life away from it; of its later retirement, followed in its train by the animals which pressed upon it from the south. We may therefore conclude that our fauna is in only a very limited sense endemic, that it was in the first instance derived from the south and secondarily shows its far-away descent from a circumpolar ancestry of warmer days.

XANTHIDIA NICIPPE.—The black bordered yellow.

[The black bordered yellow (Gosse); snow footed *Pieris* (Emmons); black bordered orange butterfly (Maynard).]

Papilio nicippe Cram., Pap. exot., iii: 31, pl. 210, figs. C, D (1782);—Herbst, Natursyst. ins. schmett., v: 170, pl. 107, figs. 3-4 (1792);—Abb., Draw. ins. Ga. Brit. Mus., vi: 15, figs. 60-68; xvi: 33, tab. 66 (ca. 1800).

Abaeis nicippe Hüb., Verz. schmett., 97 (1816);—Scudd., Syst. rev. Amer. butt., 40 (1872).

Colias nicippe God., Encycl. méth., ix: 88, 103-104, pl. 15, fig. 2 (1819).

Pieris nicippe Say, Amer. entom., ii, pl. 30 (1825);—Entom. N. Amer., ed. LeConte, i: 70, pl. 30 (1859);—Emm., Agric. N. Y., v: 205, pl. 35, figs. 6, 7 (1854).

Xanthidia nicippe Boisd.-LeC., Lép. Amér. sept., 55-57, pl. 20, figs. 1-5 (1829-30);—Scudd., Butt., 184, figs. 66, 155 (1881).

Tertius nicippe Boisd., Spec. gén. Lép., i: 653-654 (1836);—Lucas, Lép. exot., 76, pl. 38, fig. inf. (1845); Hist. nat. de Cuba, 508-

504 (1857);—Poey, Mem. Soc. econ. Hab., (2) ii: 383 (1846); Mem. hist. nat. Cuba, i: 245 (1851);—Chen-Lue, Encycl. hist. nat., Pap., 60, fig. 149 (1853);—Morr., Syn. Lep. N. Amer., 33 (1862);—H. Edw., Pac. coast Lep., 12 (ii: 6) (1873);—French, Rep. ins. Ill., vii: 148 (1878); Butt. east. U. S., 136-137, fig. 33 (1886);—Middl., Rep. ins. Ill., x: 79 (1881);—Edw., Can. ent., xiii: 61-63 (1881);—Mayn., Butt. N. E., 46, pl. 4, fig. 62, 62a (1886).

Eurema nicippe Kirb., Syn. catal. Lep., 441 (1871);—Gundl., Ent. Cub., i: 82-84 (1881).

Xanthidia lisa Peale, Lep. Amer., pl. 8 (1833).

Figured also by Abbot, Draw. ins. Ga., Gray coll., Bost. soc. nat. hist., 49;—Glover, Ill. N. A. Lep., pl. 1, fig. 57; pl. 32, figs. 10, 12; pl. A, fig. 8 (ined.).

[Not *Xanthidia lisa* Boisd.-LeC.]

To the wall of the old green garden
A butterfly quivering came;
His wings on the sombre lichens
Played like a yellow flame.

He looked at the grey geraniums,
And the sleepy four o'clocks;
He looked at the low lanes bordered
With the glossy-growing box.

And whenever a gay gust passes,
It quivers as if with pain,
For the butterfly-soul that is in it
Longs for the winds again!

He longed for the peace and the silence,
And the shadows that lengthened there,
And his wee wild heart was weary
Of skimming the endless air.

And now in the old green garden,—
I know not how it came,—
A single pansy in blooming,
Bright as a yellow flame.

HELEN CONE.—A Yellow Panay.

Imago (15: 10, 12). Head covered above with blackish brown scales and hairs, those upon the top of the frontal crest and particularly those upon the middle line of the same tipped with reddish yellow; sides and front of this ridge, and the head beneath and behind the eye as far as the level of the summit lemon yellow, some-

times tinged above with orange. Antennae blackish brown, heavily flecked, except next the base of each joint, and on the under surface only, with white; whole of under surface of club and terminal three or four joints of its upper surface dull orange. Palpi thickly clothed with scales, which are white at base, becoming gradually more and more tinged apically with yellow; upper surface and apex of terminal joint black. Tongue luteo-fuscous.

Prothorax covered profusely with delicate, forward curving, blackish brown hairs, tipped with reddish orange. Thorax black, covered with greenish yellow scales and hairs, on the patagia mingled with blackish ones and having the yellow scales, especially the outer ones, tinged with orange; beneath, the thorax is black, covered profusely with canary yellow hairs and scales, the latter tinged very slightly with orange. Coxae of front legs covered with whitish scales; femora black, concealed by yellow scales; rest of the legs whitish, duskier toward tip, the tips of the tarsal joints pale yellowish brown; spurs pale, their apical half dark reddish; spines luteous; claws dull luteous, reddish brown at tip.

Wings above rich, bright orange, the female paler than the male and made also duller by a few greatly scattered, subdued, dusky scales; the extreme base of all the wings griseous, with a sprinkling of dusky scales. Fore wings with the basal half of the costal border griseous, with mingled greenish yellow and dusky or blackish scales; upper half of exterior border of cell marked by a narrow bent streak of blackish brown; outer border very broadly margined with blackish brown, the interior border of which is either clearly defined and extends in a deep curve, starting from the costal border just above the tip of the cell (but often sending a black streak along the costal border, nearly as far as the base) and, with a slight dentation at the principal subcostal nervule and a slight indentation just above the lowest subcostal nervule, passing to the middle of the wing (where it approaches nearest the outer border—an interspace's distance) toward the inner border, continues the curve to the middle of the medio-submedian interspace, then bends back again as far as the submedian nervule and again at right angles inward, and reaches the border at the middle of its outer half (♂); or, powdery, extending from the costal border as in the male, in a nearly straight line to the middle of the upper median interspace (where it is nearest the outer border—one and a half or two interspaces distant); from here it passes by a couple of waves, but in general at about an equal distance from the border, to the middle of the medio-submedian interspace, where it suddenly terminates; beyond it, however, there are scattered dusky scales, which at the tip of the submedian nervule are clustered into a grizzly streak (♀). This external bordering, at the tip of the nervules terminating on the costal margin, is marked by obscure, pale yellow scales and the fringe beyond them is white; on the outer border the fringe is orange, obscured at base with blackish and sometimes faintly interrupted in the middle of the interspaces with blackish. Hind wings similarly bordered, the interior margin running from the costal margin, midway between the tips of the costal and first superior subcostal nervules either with a clearly defined line, in a rather deep and somewhat irregular curve, opening baseward, almost to the upper median nervule not far beyond the tip of the cell and from three-fifths to two-thirds the distance from the base of the wing; here it bends at a sharp angle outward and strikes the upper median nervule midway between the apex of the cell and the outer border, continues subparallel to the border, nearly or quite to the lower median nervule and then curves toward the outer border, where it terminates in the middle of the medio-submedian interspace, often obscured by grizzly scales (♂); or, not sharply defined, having a general straight direction, terminating at the tip of the lower median nervule; but it is broken at every nervule by the dark scales which cluster about them, forming sharp points directed inward; while a few scattered scales about the tip of the lower median nervule sometimes cause the band to terminate, vaguely, in consonance with that of the male (♀); the band in the female is uniformly dark, like that of the male, only in the subcostal region; below, it has a greater or less number of orange scales scattered through it, and sometimes asserts its presence almost solely by the dusky scales

which are always found bordering the nervules. The inner margin, as far as the submedian nervure, and often near its tip, a little way beyond it, is pale lemon yellow; fringe greenish yellow, tipped with fuscous below the lower median nervule.

Beneath: *fore wings* very pale orange, often tinged with dark greenish yellow along the basal half of the costal border; and with lighter yellow along the outer half and on the outer border; this portion, and especially the apex, is streaked faintly with short, delicate, transverse, rather infrequent lines of dusky or ferruginous scales; a small, dusky spot, sometimes obsolete, in the middle of the lowest subcostal and another in the middle of the subcosto-median interspace, and, occasionally, less distinct ones, in the median interspaces, at two-thirds the distance from the tip of the cell to the outer margin; the spot of the upper surface at the apex of the cell is repeated, less distinctly, beneath; the tips of all the nervules, except the submedian, are marked with black; fringe ferrugineo-orange, interrupted rather broadly with faint dusky at the nervule tips; costal edge blackish at base. *Hind wings* greenish yellow, occasionally tinged slightly with orange, the whole surface enlivened by short, delicate, irregular, wavy, transverse streaks of mingled fusco-ferruginous and dull orange scales, clustered across the middle of the wing, either into an irregular, broken, vague, slender stripe (δ); or, into a similarly irregular, broken, blurred, broader band (φ), crossing the costo-subcostal interspace just above the termination of the curve of the upper subcostal nervule. In the subcostal interspace following the direction of the interior margin of the black border of the upper surface of the male, but extending to the apex of the cell; it crosses the middle of the median interspace, and the medio-submedian interspace at its middle, or in broken continuity with the subcostal portion; in the female only, in the basal half of the subcostal and median interspaces, and sometimes, to a slight extent, just within the streak in the costo-subcostal and medio-submedian interspaces, the yellow scales of the ground are supplanted by dingy white scales; in both sexes, where the dusky streaks touch the costal border they become blackish and there is a blackish dot at the tip of each nervule, at the divarication of the subcostal nervure, and sometimes in the median interspaces in the middle of the stripe, which is here usually reduced to spots; fringe as on the upper surface.*

Abdomen above black, sprinkled with a few greenish yellow scales and at the base with similarly colored hairs; sides greenish yellow, the lateral line with a few dusky scales at the tips of the segments, and just beneath it tinged with orange; under surface a little paler than the sides. Upper organ of male (35:7-9) with the hook scarcely more than half as long as the centrum, reaching as far as the clasps—the latter much broader than long, furnished interiorly close to the tip with three similar laminate tooth-like serrations, fully twice as long as broad, incurved, two following each other in a curving plane, which from being vertical and directed backward inclines horizontally and inward, the third a little within the lower of the other two, directed more strongly inward than it and depressed; there is also a rectangularly toothed lamina below the middle of the upper margin.

Measurements in millimetres. Length of tongue, 14 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	19.75	22.25	25.	19.25	23.25	23.75
antennae.....	7.5	8.5	9.25	7.	8.25	8.5
hind tibiae and tarsi..	5.5	7.	7.5	5.6	6.5	7.
fore tibiae and tarsi..	4.3	4.5	5.	4.1	4.2	5.

Described from 73, 8 ♀.

*In two females, locality unknown, the under surface of the wings has a very different general aspect, being almost altogether dull ferruginous; this appearance is due to the predominance of certain features, the wing being wholly dingy white, tinged with yellowish, but almost entirely overpowered by the cross

streaks, which are almost exclusively ferruginous, but with a dull orange tinge; they are also more compact along the middle stripe, which latter becomes conspicuous almost solely by the absence of any mottling above it, corresponding to the pale portions in other females.

Variations. Boll says that he has noted dimorphism in this species but does not indicate its nature. Strecker briefly described an aberration *FLAVA*, commoner in the female than in the male, as "eltron yellow without any traces of orange." Edwards, however, says: "I have taken males of all grades up to clear sulphur yellow, with no trace of orange; the females also are often nearly yellow but I have seen none which had not a little orange in the disks."

Accessory sexual peculiarities. In the male the black bordering band of the wings is sharply defined and extends across the entire outer margin. In the female, on the other hand, the band is blurred and stops abruptly before it reaches the lower angle of the fore wings, or has half traversed the hind wings. But besides these marked differences the males have on the middle median nervure of the same surface of the fore wings, many androconia (46:36) having a very graceful, rounded, triangular form, very elongated, largest just before the very well rounded apex, coarsely striate as in *Callidryas eubule*, and nearly four times as long as broad.

Egg (65:31). With about thirty very slightly elevated but sharp vertical ribs in the middle of the egg and less than half that number at either end, about .03 mm. apart in the middle of the egg, the cross lines not at all sharply defined nor very straight, about .01 mm. apart, forming thus quadrangular cells, about three times as broad as high, the surface of which is pitted with comparatively large, shallow, oval cells, their longer axis parallel to the vertical ribs, three or four only in each cell and occupying the greater part of it. "Color when first laid, greenish yellow; after a few hours turning to red" (Edwards). Height of egg, 1.5 mm.; width at summit, .12 mm.; at middle, .42 mm.; at base, .17 mm.

Caterpillar. First stage. Head obovoid, greenish white. Body whitish, semi-transparent, a few whitish clubbed appendages scattered about each segment. Legs and prolegs of the color of the body. Length, 2.5 mm. (After Edwards.)

Second stage. Head subglobose, finely tuberculated, and somewhat pilose, yellow green. Body deep green, "dorsum, the sides and lower parts lighter"; clubbed bristles white; hairs white or black. Length, 4 mm. (After Edwards.)

Third stage. Head as before of a lighter green than the body, which is wholly deep green. Length, 5.1 mm. (After Edwards.)

Fourth stage. A specimen which is moulting differs from the last stage in wanting all the blue markings and in that the stigmatal stripe is not so broad, and pallid instead of yellow, the same pallor spreading over the whole upper surface, especially of the abdominal segments; the papillae are concolorous or only of a darker green and they have no conical appendages; that is, they are uniformly rounded and not apically elevated and angular. Length, 14 mm.

Last stage (76:6). Head (79:68) nearly uniform pea green, with inconspicuous, delicate, vermiculate markings of a slightly darker green, the papillae black; mouth parts and antennae pale greenish yellow, a little fuscous, especially along lower edge of labrum and edge of mandibles; ocelli black.

Body below of the same green as the head, above very dark green; the papillae black, bluish at extreme base and surrounded by a slight annulus of paler green; a stigmatal band of yellow, nearly twice as broad as the length of the spiracles, extends the whole length of the body, its lower edge passing near the lower edge of the spiracles; for more than an equal space above this the side of the body is marked on the middle of each subdivision of the segments with transverse rounded bars of blue enclosing several papillae, the bases of which are generally connected by a blackish area. There is also a trace of blue below the yellow stigmatal line in the middle of the segments. Legs concolorous with under surface of body, inclining to yellow toward the tips; prolegs concolorous or slightly tinged with yellow, the hairs upon them colorless. Spiracles chalky white. Length, 25 mm.; breadth of body, 8.5 mm.; of head, 2.3 mm.

Chrysalis (84:51, 52). Dull, hoary green, caused by the structure of the surface, which is delicately corrugated, the raised parts being white and the sunken portions green. The wings are slightly darker than the rest of the body and are often specked or

blotched delicately with fuscous, dottings of which generally occur also on the whole of the body; there is a dusky dorsal line, and the conical frontal projection is at least tipped with dusky when the body is otherwise wholly devoid of dusky markings, and when these are present it is almost wholly dusky, especially on the back. There is always a more decided collecting of dusky dots along the ventral line of the abdomen, especially near the wings. Length, 19 mm.; breadth, 4 mm.

Some chrysalids are quite largely sprinkled with brown dots and patches over whole anterior part, including wing cases, and the keel is brown. Two chrysalids bred in September, 1880, differed from all the rest in that they were black or black-brown; the anterior parts darkest; one of these had the posterior part of the ventral prominence, beyond the wing cases, dull green; both had the two pairs of spots above mesonotum white. I thought it probable that these chrysalids were diseased, but both gave imago in no way differing from the usual form. Duration of the chrysalis stage in July and August 8 days." Edwards (Can. ent., xiii: 62-63).

Geographical distribution (26: 1). The distribution of this butterfly is very similar indeed to that of *Terias lisa*. In the south it is recorded as one of the commonest butterflies; "throughout the entire summer it swarms in myriads," says Grote, writing from Alabama. The only exception to this description is found in Abbot's manuscript where he says it is "not common" in Georgia. The butterfly is found from the Atlantic to the Pacific and in most of the states south of Lat. 40°. In the south it is abundant as far as the Gulf, has been brought from Key West by Maynard and Palmer, is common in Texas to its extremest boundary (Aaron, Lintner), and south of our own country occurs abundantly in Cuba (Gundlach, Wright), and on the continent through Mexico (Palmer, Sallé), to Guatemala (Van Patten), and Chiapas (Reakirt). Specimens in Boisduval's collection are even stated to come from Brazil. It occurs throughout the Mississippi valley as far north as Racine, where it is "accidental" (Hoy), and west of that and north of Arkansas it is found in central Illinois (Barnes), northern Illinois (Worthington), Iowa (Chicago Museum), Missouri (Museum Michigan University, Cambridge Museum), eastern Kansas "common" (Snow), Colorado (Nash, Reakirt). South of the higher Rocky Mountains it is found still further west; thus it is reported from New Mexico (Snow), Arizona (Morrison, Mead, Doll), and even southern California.—San Diego and Kern Counties (H. Edwards). Easterly it is found common in the southern half of the Alleghanian fauna. Doubleday states that it flies "in profusion" in Illinois and Ohio, and Kirtland says that in Ohio it is "occasionally found in the valley of the Mahoning River and is abundant at Columbus and Dayton," but he had never observed it in the vicinity of Cleveland. Saunders says it is occasionally found in western Ontario. It is "usually common" in Maryland (Uhler), "common" at Philadelphia (Blake), and found at Rutherford Park, N. J. (Meyer). Davis reports that it was common on Staten Island in 1880, but was not observed before nor has it been since. It is reported by several observers from Long Island (Graef, Akhurst, Tepper), and at Newburgh, N. Y. by Miss Morton.

These last records would of themselves render it probable that it would occur in New England, but it has very rarely been found here; the only instance that has come to my personal notice has been a specimen obtained at Norwich, Conn. by Mr. Theodore McCurdy, and a report by Mr. W. H. Edwards that from the railway train he saw one flying near Brockton, Mass., July 25, 1877,—the same year, it will be noted, in which it was common on the Hudson.

Abundance and haunts. The butterfly, according to Doubleday, frequents open plains near forests and clover fields, associating in the latter with *Eurymus philodice* and *Zerene coesonia*. It is variable in its abundance, at least toward the limits of its range. Thus Miss Morton found it on the banks of the Hudson more common than even *Eurymus philodice* in 1877, but not a single specimen in the following years; a similar statement is made by W. N. Tallant of Columbus, Ohio, who did not see a single specimen in 1879, while in 1880 they were more numerous than *Eurymus philodice*.

Oviposition. The eggs are laid as a rule on the lower side of the leaf, but they may also be found upon the upper side, and less care is taken in choosing the more tender leaves than *Callidryas* employs (Riley). Many eggs are sometimes dotted over the surface of a single leaf, according to Edwards.

Food plants. *Cassia marylandica*, the wild senna, in the northern and *Cassia tora* and *C. occidentalis* in the southern half of its range seem to be the favorite or only food plants. Messrs. Riley and Edwards find it on the ~~first~~ ^{first}, Abbot and Dr. Chapman have raised it on *C. tora*, *C. occidentalis*, Dr. Chapman thinks, is what Abbot meant by "yellow indigo," and Gundlach finds it on both the latter two species in Cuba. Boisduval and LeConte say it feeds on different species of *Trifolium* and *Cassia* and many other Leguminosae; but none have been specifically mentioned and I have found that the larva will starve rather than touch *Coronilla* or *Tephrosia*.

"The larvae commence to feed on the tip of the leaf, eating the extreme leaflets first" (Riley).

Life history. The annual life history of this common butterfly has never been properly worked out by any one, and the memoranda at hand are insufficient to speak with precision. It undoubtedly hibernates as a butterfly, as specimens have been repeatedly known to emerge from the chrysalis at the very end of the season; they appear occasionally on the wing in midwinter in the extreme south, and, in the spring, but few are seen until the first, comparatively late, fresh brood of the year appears. Moreover in the winter of 1875-76, Mr. W. H. Edwards of West Virginia placed butterflies which had emerged late in October in his cellar, and on January 24 found them all alive and in the same positions in which

they had been placed in the cellar. The butterflies remain on the wing in northern Florida until November and, by Dr. Chapman's notes, appear again early in February, but only in scanty numbers, only two or three specimens being seen any day until May, about the middle of which month fresh individuals appear; by the end of this month they become abundant and continue so throughout the rest of the season, there being a notable accession of fresh material about the second week in August. These two dates then, the middle of May and the middle of August, doubtless mark the advent of fresh broods. As Edwards says that in West Virginia "the butterfly is present in several successive generations and in overlapping broods from early in May to winter," and as, according to his figures, it takes less than a month for the passage of the preparatory stages, there is without doubt a brood between these two. Maynard says that there is evidently a fresh brood in Florida in November and the same thing appears to be true in Georgia, judging from specimens received from Dr. Oemler; so that it appears most probable that there are at the least four regular broods. These become confused toward the end of the season; thus Edwards says: "On one day in September . . . I cut a branch of wild senna (*Cassia*) on which at the moment were newly laid eggs . . . larvae in every stage of growth and a butterfly . . . just emerged and still resting on the empty shell of its chrysalis" (*Can. ent.*, vii: 192); and he afterwards adds "there were forty larvae on one stem."

The duration of the egg state in midsummer, according to Edwards, is only two or three days, the different larval stages about the same, and the chrysalis hangs eight days in July and August. Abbot gives the same period for the chrysalis in Georgia. In Cuba, according to Gundlach, the chrysalis hangs only six days in September. Riley tells me that in Missouri he found it to last from five to eight days in September.

The butterfly, according to Doubleday, frequents open plains near forests and clover fields, in the latter of which it associates with *Eurymus philodice* and *Zerene coesonia*, whose flight it resembles more than it does that of its nearer allies. Maynard, however, calls its flight sluggish, and Gundlach states that it is very direct, and he adds that it assembles in flocks on moist mud like other *Rhodoceri*.

Parasites. With the caterpillar of this butterfly, Riley found in Missouri the cocoons of a parasitic hymenopteron, *Apanteles cassianus*, up to the present its only known special enemy.

Desiderata. We have endeavored to trace an outline of the history of this butterfly but upon very insufficient data; the sequence of the broods needs following upon the spot, where also it should be determined whether the insect hibernates otherwise than as a butterfly, and if so, what proportion of the hibernators are butterflies. Do the October and November butterflies ever lay eggs the same season? The earliest larval stage is in-

sufficiently characterized and too little is known of the flight and postures of the butterfly, its habits or that of the caterpillar.

LIST OF ILLUSTRATIONS.—*XANTHIDIA NICIPPE*.

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| <p><i>General.</i>
Pl. 26, fig. 1. Distribution in North America.
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Pl. 65, fig. 31. Plain.
<i>Caterpillar.</i>
Pl. 76, fig. 6. Full grown caterpillar.
79: 68. Head, fifth stage.
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Pl. 84, fig. 51. Side view.
52. Dorsal view.</p> | <p><i>Imago.</i>
Pl. 15, fig. 10. Female, both surfaces.
12. Male, both surfaces.
35: 7, 8, 9. Male abdominal appendages.
40: 9. Neurulation.
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EUREMA HÜBNER.

Eurema Hübn., Verz. bek. schmett., 96 (1816).
Terias (pars) Auctorum.

Xanthidia (pars) Auctorum.
Type.—*Papilio delia* Cram.

'Tis a woodland enchanted!
When the phebe scarce whistles
Once an hour to his fellow,
And, where red lilies flaunted,
Balloons from the thistles
Tell summer's disasters,
The butterflies yellow,
As caught in an eddy
Of air's silent ocean,
Sink, waver, and steady
O'er goat's-beard and asters,
Likes souls of dead flowers,

With aimless emotion
Still lingering unready
To leave their old bowers;
And the fount is no dumber,
But still gleams and flashes,
And gurgles and plashes,
To the measure of summer:
The butterflies hear it,
And bull-heads are bolder,
Still bawling near it
O'er goat's beard so golden.
LOWELL.—*The Fountain of Youth.*

Imago (56: 3). Head not very large, profusely covered with rather short, coarse, scale-like hairs, longest on the front. Front very slightly and rather uniformly tumid, slightly depressed in front of the antennae, with a slight median ridge between the antennae, parting posteriorly into still slenderer, diverging forks, opposite the middle of the antennae and reaching their posterior edge; a little hollowed down the whole middle of the front; a little higher than broad, scarcely more than half as broad as the eyes on a front view, the sides diverging considerably upward; upper border sloping toward and rounded off at the antennae; lower border squarely docked. Vertex tumid, higher than the level of the eyes, with exceedingly broad, rather deep, oblique sulcations, separating the more swollen centre from the tuberculated, projecting, outer angles of the front border; the latter raised and ridged throughout its extent. Eyes not very large, full, naked. Antennae inserted with the hind edge slightly in advance of the middle of the summit, in distinct pits separated from each other by a space fully equal to the diameter of the second antennal joint; scarcely more than three-quarters the length of the abdomen, consisting of thirty-five joints, of which about fourteen form the rather strongly compressed cylindrical club, nearly four times as broad as the stalk, fully four times as long as broad, increasing very gradually in size to the middle of the apical third, the last three joints forming a well rounded tip, the terminal one with a minute, conical, bluntly pointed apex; down the middle of the under surface, occupying the width of each joint, is a row of large, shallow, circular depressions. Palpi very short and moderately slender, compressed, scarcely longer than the eye; last joint minute, less than half as long as the penultimate, which itself is scarcely two-thirds as long as the basal joint; all the joints clothed rather heavily with scales, which do not protrude greatly beyond the border.

Prothoracic lobes very small, fabiform, half as broad again as high or long, somewhat tumid, placed obliquely. Patagia of moderate size, rather long and rather broad, somewhat arched, scarcely tumid, not more than three times as long as broad, very gradually tapering, the apical half bent slightly outward, nearly equal and half as broad as the base, the tip broadly rounded.

Fore wings (40:4) nearly three-fourths as long again as broad, the costal margin rather strongly convex at the base, beyond broadly rounded, the middle half a little flattened; outer angle well rounded off, outer margin nearly straight, scarcely convex, bent at an angle of about 60° with the general direction of the middle half of the costal border; inner margin scarcely emarginate about the middle, the outer angle rounded off. Costal nervure terminating at the middle of the costal border, the subcostal with three superior branches, the first arising in the middle of the outer two-thirds of the cell, the third at an equal distance beyond the apex of the cell, its upper branch forked at nearly as great a distance from its base, and the second arising from the apex of the cell. Cell a little less than half as long as the wing, and scarcely three times as long as broad.

Hind wings with the costal margin somewhat and rather abruptly rounded next the base, beyond pretty broadly and regularly rounded, rather fuller in the δ than in the ϕ ; outer margin pretty strongly and regularly convex above the lower median nervule, beyond continuous and nearly straight, fuller at the extreme upper limit, and so with a more regularly rounded upper angle in the ϕ , fuller in the middle of the subcostal region in the δ ; inner margin broadly and abruptly expanded next the base, beyond straight or scarcely convex, the angle rounded off. Costal nervure without any branch; vein closing the cell striking the median nervure twice as far beyond the second divarication as beyond the same divarication of the subcostal nervure.

Fore tibiae about two-thirds the length of the middle tibiae; fore tarsi scarcely shorter than the fore femora and nearly four-fifths the length of the middle or hind tarsi; hind femora about three-fourths as long as the middle pair in both sexes. Femora slenderly fringed with rather long, scale-like hairs. Tibiae supplied abundantly and equally on all sides with very small and very slender, recumbent or nearly recumbent spines, scarcely arranged in rows, and apically with a pair of not very long, exceedingly slender spurs. First joint of tarsi scarcely equalling all the others combined, the third and fifth equal, and the fourth less than half as long as the second, provided with spines similar in character and disposition to those of the tibiae, but below arranged in four regular rows, an apical pair of spines on each joint considerably longer than the others; claws very small, divaricating but little, compressed, not greatly but regularly curved, broadly bifid for fully half the depth, the branches of equal length and similar, finely pointed; paronychial simple, composed of a compressed lamella, broad at base, rapidly tapering, forming a rather slender pointed lobe, extending very nearly as far as the claw and partially concealing it; pulvillus similar to that of *Callidryas*, but not mounted on so long a pedicel.

Tip of eighth abdominal segment very broadly expanded, so as above to be scarcely longer than the seventh, and receding only in the middle of the sides. Upper organ of male appendages curved, long and slender, excessively compressed so as to form a laminar blade, the lower edge of which is thickened. Clasps subtriangular, convex only at the borders, bluntly pointed posteriorly, both upper and lower edges recurved and bearing one or two laminate teeth.

Egg. Rounded subfusiform or Indian-club shaped, between three and four times as long as broad, largest below the middle, but nearly equal in the middle half, tapering above much less rapidly than below, the upper third tapering regularly to the narrow, subtruncate and gently rounded summit; lower extremity much more broadly rounded, with a parabolic curve; sides furnished with numerous, excessively delicate, vertical ribs, equally elevated throughout, the interspaces broken by cross lines, scarcely more delicate, into nearly square cells.

Caterpillar at birth. Head of the same size as the rather large first thoracic segment; bearing about twenty longer and shorter hairs definitely arranged, of which the

most conspicuous are a pair of very long ones, one a little within the middle of either hemisphere, at the level of the top of the triangle, four small but unequal, inequidistant ones, a little outside the whole length of the sides of the frontal triangle, and a pair of small ones across the middle of the same. Body slender, slightly moniliform, due in large part to a substigmatal expansion, on which the papillae of that point are placed. Papillae conical, higher than broad, arranged, besides the transverse series of the first thoracic segment, in an anterior, laterodorsal series on all the other segments; a supralateral series anteriorly placed on the thoracic, posteriorly on the abdominal segments; an interior, infralateral series on all the segments; and an infrastigmatal series, two to a segment, centrally and posteriorly placed on the abdominal, the latter almost stigmatal, one and central on the thoracic segments. Hairs straight, long, erect, very delicately tapering, slightly expanded and open at the tip. Segments divided into a large anterior and four equal, smaller, transverse sections.

Mature caterpillar. Head of the normal form, three-quarters the breadth of the body, studded very regularly with minute papillae, bearing erect and forward directed, short, tapering hairs. Triangle more than half as high as the head, slender, more than twice as high as broad. Ocelli five in number; four subequidistant in a gently curving, vertical row, the fifth posterior, with the first and third forming a nearly equilateral triangle. The mandibles massive, chisel-edged. Antennae unusually small, the bristle very long.

Body very slender, about seven times as long as broad, equal or scarcely tapering behind the fifth abdominal segment, the last segment more rapidly to a truncate, broadly emarginate tip. Segments divided by transverse incisions into six subsegments, of which the second to fourth are subequal, the first half as large again as either of these, the sixth smallest, all furnished with a large number of minute, short, conical papillae, mostly arranged in a single transverse row on the narrower subsegments, but with scarcely any regularity whatever on the first subsegment; a few regularly disposed in longitudinal series; on the first section of each segment a latero-dorsal, and on the fourth a lateral series of papillae larger than the others, rounded conical broader than high, and bearing hairs twice as long as the others, about as long as the longest subsegments, minutely expanded at the apex, and supporting globules. Spiracles long, oval, small and lenticular. Legs and prolegs short, the front pair of legs much shorter than the others, so far as the fleshy basal joints are concerned.

Chrysalis. In general the body is much slenderer than in *Eurymus*; viewed from above, it is bell-shaped in front of the basal wing tubercles, the apex produced to a moderately long, conical point, the distance from the extreme point to the basal wing tubercles being about the width of the body; the sides of the bell are most convex at the ocellar ribbon, but the sinuate course of either side is but slightly removed from a straight line. Behind the basal wing tubercles, where the body is broadly angulate, the body is equal as far as the end of the wing cases; beyond this, very gently and regularly conical to the tip of the cremaster, which is truncate and roundly emarginate. Viewed laterally the body is more irregular and, excepting for the inferior expansion of the wings which adds to the height of the body by two-thirds, quite straight. The head and the prothorax have an independent curve of their own, being subglobular and apically somewhat constricted at the base of the frontal tubercle. The mesothorax is gently arched, and interrupts the very broad curve which otherwise would continue from the back of the head to the tail. The inferior expansion of the wing cases is midway in character between *Callidryas* and *Eurymus*, and beyond them the ventral line is a continuous broad curve to the base of the cremaster, which viewed laterally, is slender, twice as long as broad, equal. There is a slight, dorsal carination over the thoracic joints, the two lateral surfaces being inclined to each other at scarcely more than a right angle, the carina rounded; a similar carina, but at an angle of 105° , follows the sides of the body from the basal wing tubercle to the extremity of the wing cases. The tongue cases terminate just beyond the tips of the antennae, which reach the lowest portion of the swollen wing cases. Abdomen slightly depressed above, with an obscure, rounded carina in continuation of that

upon the wings, and continuing to the sides of the cremaster. Preanal button terminating in front in two little appressed teeth; cremaster abundantly supplied with hooks, consisting of a moderately long pedicel, enlarged slightly and gradually from the tip to its extremity, the thickened extremity consisting of the quarter of the shell of a sphere, thinning toward the edge. Spiracles very long oval, scarcely protuberant.

This is a strictly American genus richly represented within the tropics, especially north of the equator and above all in the Antilles; two or three species occur in the southern United States, one of which (found also in the northern Antilles) extends to the southern limits of New England.

The butterflies are among the smallest of Pierinae, seldom varying far from an inch and a half in expanse. They are pale or bright sulphur yellow, the apex of the fore wings bearing above a very large, dark brown patch, the inner edge of which crosses the wing diagonally; the upper half of the outer border of the hind wings is usually bordered with the same and a small spot is often found at the tip of the cell, both above and below, excepting on the upper surface of the hind wings; the under surface of the latter is very variable, mottled and clouded with rosy ferruginous tints, often disposed in transverse bands and usually forming a conspicuous spot at the tip of the upper subcostal interspace.

The insects appear to be more than single brooded, but their life histories are insufficiently known. The butterflies, says Bates, "although insects of feeble flight fly directly onwards like most of the Pierinae." Wallace calls them denizens of the woods on the Amazons, and says they prefer "the dry and more open parts of the forest country and often even come out into the full sunshine." Gosse, writing of the Jamaican species, says (*Ann. mag. nat. hist.* (2) ii: 113-14):—

"I may remark of all these as well as of the genera just named [*Callidryas*, *Gonepteryx*] that in a road they do not hover about or play backward and forward as some butterflies do, but pursue the course of the road, one way or the other, and that notwithstanding the occasional interruptions of alighting, with pretty constant regularity, mostly keeping to that side of the road on which each may happen to be. I think I have remarked that most go the same way, though without any association. Occasionally one may be observed to return upon its course, but in such case it commonly pursues the new direction with the same regularity until out of sight. But the more proper and peculiar resorts of the Teriades are large open plains, old pastures and gulinea grass pieces, especially the former two, which are generally overrun with herbaceous weeds as the *Asclepiadeae*, various species of *Cassia* and *Papilionaceae*. . . . Here they flit two and fro without any regularity a few inches above the ground or herbage, alighting every instant."

The eggs are very graceful objects, shaped like an "Indian club" without the handle and are laid singly.

The caterpillars resemble those of *Eurymus* but are more slender; they are principally green with a paler lateral stripe and feed on *Leguminosae* and perhaps only on *Cassia*.

The chrysalids are straight with the wings somewhat produced, though not so much as in *Xanthidia*, and have a slight dorsal elevation on the

thorax; the frontal prominence is delicate and tapers gradually without being very long; they are green with a lateral stripe.

The species of this group, says Bates (Journ. ent., 1861, 245), referring to this genus and its immediate allies, "are a most difficult study. . . . Their specific characters are not at all trenchant; the peculiar markings which may serve to distinguish well characterized examples of a species are subject to become obsolete in other examples; the species again present many local varieties in different parts of their area of distribution." This is due, no doubt in part to the prevalence of seasonal dimorphism in this group,—a fact which was not known when Bates wrote and which will doubtless necessitate an entire revision of the species, though not in the headlong manner adopted by Pryer in his *Lepidoptera nihonica*.

EXCURSUS XLII.—THE SWARMING AND MIGRATIONS OF BUTTERFLIES.

. . . Before your sight
Mounts on the breeze the butterfly—and soars,
Small creature as she is, from earth's bright flowers
Into the dewy clouds.

WORDSWORTH.—*The Excursion*.

No flying insect steers its course by its tail.

ARISTOTLE.—*Hist. Anim.*, vii.

WHETHER or not swarming is a necessary precedent to migration among insects is not known, since migration can readily be observed, and in fact has been observed, only when an insect is exceptionally numerous; migration may be far more common than we imagine, and it seems to be one of the conditions of the struggle for existence that each kind of animal should endeavor to spread its domain.

In a preceding excursus (pp. 376-379) we have brought together some examples of the movements of butterflies *en masse*, but in most cases these were instances of forcible removal from one point to another by atmospheric agencies. It may be remarked in passing, that such massive movements could not have occurred but for the habit, on the part of the insect involved, of congregating in such great numbers as to merit the term swarming. At present, however, we are not concerned with the involuntary but with the voluntary massive movements of butterflies.

Such movements have frequently been observed and in some quarters of the globe, notably in tropical regions, are claimed to be a regular and annual occurrence. There is reason to believe that this may also be true, on a smaller scale, in temperate regions. Hardly more than three sub-families of butterflies have been observed to be concerned in such movements, viz., the Nymphalinae and Euplocinae among Nymphalidae and

the Pierinae among Papilionidae. Some examples may be given, following a systematic order.

Chlorippe celtis, one of the *Apaturidi*, was reported in 1887, not only to be swarming in great numbers in our southern states, but to be migrating, though I have been unable to obtain any definite statements regarding their movements.

Most of the cases, however, occur among the *Vanessidi*. Thus Mr. B. P. Mann, while resident in Brazil, observed on Feb. 17 (early autumn) great numbers of *Coea acheronta* following each other singly at intervals across a meadow in front of his house, apparently migrating; "the butterflies came with powerful, rapid, direct flight, perhaps from three to five meters above the level of the meadow, from the direction of a small hill near by."

Another case within the tropics is recorded of a very different butterfly by Mr. Pelt, which I give in his own words:—

As we rode along, great numbers of a brown, tailed butterfly (*Timetes chiron*) were flying over to the southeast. They occurred as it were in columns. The air would be comparatively clear of them for a few hundred yards, then we would pass through a band perhaps fifty yards in width, where hundreds were always in sight, and all travelling one way. I took the direction several times with a pocket compass, and it was always southeast. Amongst them were a few yellow butterflies, but these were not so numerous as in former years. In some seasons these migratory swarms of butterflies continue passing over to the southeast for three to five weeks, and must consist of millions upon millions of individuals comprising many different species and genera. . . . I know of no satisfactory explanation of these immense migrations. They occurred every year whilst I was in Chontales, and always in the same direction. . . . The difficulty is there are no return swarms. (*Nat. in Nicaragua*, 152-3.)

In Europe, the phenomenon has been observed in the allied *Eu Vanessa antiope*, whose irregularity of abundance is well known; thus Swainson says on Lewin's authority that in Great Britain "in March, 1790, a great number were seen flying and soaring about for the space of twelve or fourteen days; and then as if with one consent, they migrated from us and were no more seen." The powers of flight of this insect are referred to above (p. 409).

Fritsch of Prague states that a migration of butterflies, presumed to be *Aglais urticae*, was seen at Laibach, which was about four hundred metres broad and lasted for half an hour. And Cornelius says that a flight of this same butterfly, lasting for half an hour, passed in a southeasterly direction over the Lake of Neuchatel in July, 1828.

We can return to our own country for the next instance, which is related by Behr of *Eugonia californica* and is the more interesting when we recall the nocturnal flight of the allied *E. j-album* related above on p. 377. Dr. Behr says:—

The first migration I observed was on November 15th, 1856, when numbers of this butterfly flew over San Francisco in a general direction of south-south-east. They

flew singly, and never crowded into swarms. Most of these butterflies passed over our streets at too great a height to permit close inspection—a few alighting here and there on lamp-posts, sign-boards, or in the more rural parts on flowers. It was from these that I obtained the specimens in my collection. They nearly all looked worn and shattered, and there were no fresh specimens among them: clearly indicating that they were not raised in the neighborhood of the city, but had come from distant parts. On the 18th some of the stragglers were still to be seen, but on the 19th they had all disappeared. The second migration took place last fall [1863], but did not reach San Francisco. . . . By comparing notes received from Mr. Johnson, of Marin County, I have come to the conclusion that the country to the northward crowded with this *Vanessa*, must have sent at least one colony south; and I was told by the above-mentioned gentleman, the statement being confirmed by several intelligent farmers of the same neighborhood, that large numbers of a brown butterfly had come from San Quentin, and crossed over that part of the bay which stretches between San Rafael and Sausalito. About the same time, great numbers of the same insect were observed in Lagunita Valley, at the base of Tamal Pals, where the swarms gathered in a great crowd, and disappeared as suddenly as they came. (Proc. Cal. acad. nat. sc., III: 124.)

Perhaps, however, the most striking instance in modern times, because noticed and recorded by so many persons, is the invasion of Europe by great swarms of *Vanessa cardui* during the summer of 1879. They were first observed at the end of May at two points considerably distant from each other. Ritter says that he was near Nikolsburg in Moravia on a hot sunny day at the end of May by the edge of a forest, when at about two o'clock in the afternoon, he noticed a peculiar humming sound. "Immediately," says he, "I observed an enormous flight of butterflies which came in a westerly direction over an open forest park and pitched as by command on the sunny wall opposite me." He hurried off to find others to witness the sight, but on his return in five minutes, found only one or two individuals instead of the many thousands he had left there. The other observation was much farther to the south. Ninni has collected the facts regarding this swarm, which appeared at Treviso north of Venice between the 30th of May and 6th of June. On the 30th, he says, there were comparatively few butterflies, all passing in a northwest direction. On the 31st the same, the wind at this time coming mostly from the north. On the 1st of June with wind mostly west of north, they moved in a direction to the east of north, and this direction they retained for the three following days. On the 2d they came in immense numbers, flying from 5.15 A.M. till sunset, the wind varying on either side of north. On the 3d the numbers were still great but began to decrease, with the prevailing wind from the north-east, so that they were flying directly against the wind, which had now attained a greater strength. On the 4th, with the wind more in a southerly direction, they moved in the same direction as before but were only remarked at certain points. On the 5th, with the wind in an easterly direction, the numbers were about as on the previous day, while on the 6th with the prevailing wind from the north-east, the flight only began at 1 o'clock in the afternoon and lasted for an hour and a half.

In the early days of June and particularly about the 7th, the butterflies appeared all over the central portions of Europe moving, as a general rule, at right angles to or against the wind, but with a prevailing direction from the south-west toward the north-east. They passed over all obstacles without hesitation; thus on the 5th of June thousands of them were found dead on the snow around the St. Gothard hospice, only a day or two after which they appeared in immense swarms to the north of the Alps. That it was not simply a superabundance of butterflies already existing in the region, but an inflow from outside, seems to be abundantly proved by two facts: first that in the principal regions of the invasion, *cardui* does not appear upon the wing (excepting in the few which hibernate) until the middle or end of July, whereas the invasion took place at the end of May and the first half of June; and second by the condition of the specimens concerned in the invasion; wherever captured, with a single exception, that of Ritter, all specimens were noted as very worn and faded, indicating that they had flown from an immense distance. Oberthür, capturing specimens of the flight which made its appearance at Rennes on the 10th of June, remarked that they belonged to a very characteristic African type, noticeable for the fact that the brighter parts of the upper wings are very much paler and less rosy than in the type found in France. Specimens, indeed, seemed to him to be precisely like those which he had in his collection coming from Abyssinia. Now as it is well known that *cardui* flies during the entire winter in the north of Africa, laying its eggs and raising its broods throughout this season in Egypt, where I have myself seen it in the imago, caterpillar and chrysalis state in the greatest profusion during the month of March, there is no reason for disbelieving the conclusion that nearly all who have examined the question appear to have reached and which has been formulated by several writers, that this was literally an invasion of butterflies which had flown across the Mediterranean and spread over the greater part of Europe. It does not seem to me necessary to suppose they crossed at any given point or during the day-time only.

According to Speyer, the movement of the butterfly streams were observed as far as the 50th degree of latitude, but accompanied, he says, by an unusual frequency of this butterfly otherwise over all England, Germany, Hungary and even as far as Finland. Schmidt, however, without apparently having observed any flight, states that at Vismar, as far north as the Baltic coast and near latitude 54°, *cardui* was excessively abundant, and all very worn and faded; and it is quite possible that the superabundance of the butterfly found to the north, in England and elsewhere, during this year may have been due to the presence of the invading horde whose progeny they represented.

To follow for a week the fortunes of this invading horde, we would observe

that on the 7th of June flights of the butterfly were noted at no less than nine or ten widely separated places in different parts of Europe, especially in south-western Germany, Switzerland and Moravia; in the vicinity of Zurich, an observer, who noted the flight at half past four in the afternoon and found it still continuing at five, calculated that a thousand individuals passed over his head within the space of eight minutes, forming a stream about ten metres wide. Near Hüningen they were observed crossing the Rhine for many hours, passing in an easterly direction. On the 8th they were observed at Carlsruhe, Strassburg, Stuttgart, and near Zurich, in the last place flying very swiftly in immense swarms, during a couple of hours in the afternoon, over a space a kilometre broad and from two to ten metres high. On the 9th, Forel reports that a passage of butterflies occurred at Morges and Lausanne, lasting from one to four hours; and it was probably this species seen moving westward at Olmütz, Moravia, between 1 and 2 P. M. On the 10th they were observed at Carlsruhe and other places in the vicinity, and at Angers, France, where they passed in a westerly direction against a feeble wind; this was the day on which the flight was observed at Rennes by Oberthür, who gives some interesting estimates, calculating that the butterflies moved about fifty metres in ten seconds; sometimes twenty or thirty would be seen in a single minute, following one another without interruption, sometimes four or five close together; they flew over all obstacles, passing vertically up the walls of houses in their way, always surmounting obstacles, never passing around them. The flight began at half past eleven in the morning, moved in a northerly direction until two o'clock in the afternoon, when its direction was suddenly changed to the west, and an hour afterward the wind itself began to veer to the east, blowing up a storm in the course of another hour. On the 11th, swarms were observed at Nancy, at St. Franc, Savoy, 600 metres above the sea, at Salzburg, and at Steyer in upper Austria, where they were on the move from nine o'clock in the morning to six in the afternoon, though most abundant between one and two in the afternoon, and it was calculated that, over a breadth of 100 paces, from 90 to 110 passed in a minute, making more than a million of individuals during the day. On the 12th the flight was observed at Lautschitz in Bohemia, on the 15th at Augsburg, and again, between four and five o'clock in the afternoon, at Salzburg, passing here at the rate of about 750 in an hour. The streams were noted every day from the 10th to the 16th near Paris, and especially on the 13th, always passing in the same direction, toward the west. Dr. Regenbart even asserts that at Evreux, France, there was a continual passage of this butterfly from south to north throughout the whole of June, without the omission of a single day, and even during moderate rain, the butterflies flying near the ground with great rapidity, surmounting all obstacles and never turning aside, all with torn and faded

wings. On the 16th flights were observed again at Salzburg and at Armainvilliers. After this, observations are less frequent and important.

This is by no means the only invasion that Europe has suffered at the hands of *Vanessa cardui*; a number of earlier instances are on record, and almost all of them occurred at about the same time of year; that is, in the spring, before the time for the regular appearance of the indigenous brood of the butterfly. The first of which I find any record is mentioned by Cornelius as having taken place at Turin at the end of May, 1741. Several subsequent flights have appeared in this immediate vicinity. Thus De Loche saw a flight there in May, 1791, there was another at the close of May in 1798, and Huber states that Bonelli saw one toward the end of March, 1826, passing from the south toward the north; apparently this lasted several days, for it is stated that the butterflies were most abundant on March 29. On April 26, 1851, Ghiliani saw a great flight of these insects; according to Bouquet, the day was fine, after continued rain, and a strong breeze blew from the west; beginning at 11 A. M., the swarm came from the south-southeast and continued with a precipitate flight for five hours towards the north-northwest. Again in 1857, when, according to Cornelius, a flight occurred on April 26. All of these were in Piedmont. Huber gives an account of a flight seen by Wolf near Neuchâtel, on the 8th of June, 1826, which lasted at least two hours, the stream of butterflies being from ten to fifteen feet broad. The same flight is recorded June 8th, in the neighboring Canton Vaud at Granson, moving northward, according to Cornelius, who further records a flight which passed from London to the coasts of France in a south-easterly direction, in 1857, without specification of the month, and one which occurred in April and May, the year not mentioned, at Montpellier, passing in a northerly direction and composed of both sexes. The only definite exception to the universal occurrence of these flights in the spring is the statement, recorded by Hagen, of a flight in Switzerland, when, on October 26, 1827, Prevost saw such a moving swarm, composed of a stream of butterflies, from ten to fifteen feet broad, passing from south to north for two hours.

Among the *Euploecinae* similar migrations are well known. Thus Thwaites says in Moore's *Lepidoptera of Ceylon* :—

On a fine sunny day, when calm or nearly so, amazing numbers of one or more species of *Euploea* may often be observed wending their way in one direction, as if floating upon the air a few feet from the ground, with an apparently sluggish movement of their wings, though really making rapid progress. Resembling an army in scattered open columns, they move on instinctively, regularly and simultaneously, as if animated by a true migratory impulse. They naturally suggest a most interesting inquiry as to whence these immense numbers come, and whither they are tending, whether their course is a straight-ahead one, or is following a horizontal circular direction of greater or less diameter. These insects when thus moving in company show an unwillingness to be diverted from their course, and when attracted by a favourite plant in flower, it is only for a few minutes that they remain upon it, and after

regaling themselves, soon start off to resume their journey with their fellow travellers, moving again amongst them as before and bound for the same destination. It is curious to observe that butterflies of a totally different kind, when they happen to come within the range of one of these moving columns, are, for a period, carried away apparently by the same impulse and fly in company with it, but are soon seen to be moving off independently as at first.

Another instance in the same family is our *Anosia plexippus*, for an account of whose movements, which I believe I have shown good reason to consider periodic, the reader is referred to that species and especially to pp. 727-737, 741-745. To the accounts there given of its swarming upon trees may be added that of Mrs. Bush of San José, Cal., who writes to the American naturalist:—

I have been to Monterey, and was fortunate enough to see the "butterfly tree," or trees, as there are three of them. These trees are the Monterey pine (*Pinus insignis* Dougl.), and are probably over one and a half feet in diameter, and completely covered with live butterflies. To say that there were as many butterflies as leaves upon the trees would not be a very great exaggeration. I saw them in the morning when it was cool and they could not fly very well, and picked up a dozen from the grass in a few seconds. A lady resident informed me that for the twelve years she had lived there the appearance had been the same. (xv: 372.)

Since the printing of those pages, the following account of the migratory movement has been given by Dr. Ellzey, as observed at West River, Md., Sept. 23, 1886:—

About 7 o'clock in the morning my son, G. Murray Ellzey, called the attention of myself and several other gentlemen to the fact that "the whole heavens were swarming with butterflies." There were an innumerable multitude of them at all heights from, say, 100 feet to a height beyond the range of vision, except by the aid of a glass. They were flying due southwest in the face of a stiff breeze. Observations upon the flight of individuals between points of known distances apart showed that the rate of movement was not far from 20 miles per hour. Where they originally came from or whither they went we could not tell. They undoubtedly came from beyond the bay, which, in that place, is 14 miles across, and they must have been early on the wing. By 11.30 o'clock the numbers had declined, and it was evident the bulk of the flight was over, but for several days a great many individuals, evidently following the migratory movement, were observed. My brother-in-law, Mr. Daniel Murray, who had been three days previously, viz., on the 20th of September, at Long Green, in Baltimore County, Md., saw a vast multitude of the same butterflies in migratory movement; they were seemingly exhausted in flight and settled on the trees in such multitudes as to give them the appearance of an autumnal forest. (Insect life, i: 221.)

I had also overlooked the statement by Werneburg that the *Deutsche Romanzeitung* (1872, 319) mentions a passage of this butterfly in Connecticut in 1871 towards the southwest, which passed at a height of from 100 to 160 metres overhead *in endlosen massen*.

The most common examples, however, of migrating butterflies are to be found in the subfamily remaining to be considered, the Pierinae, where more than elsewhere there is a remarkable general propensity for congregating, these being among our most social butterflies. Instances of this

have already been given under *Callidryas* and others will be given, to which we may add the following, drawn from miscellaneous sources, first regarding the *Rhodoceri*, next the *Pieridi*.

Swainson says that Lindley saw in Brazil, in March 1803, "an immense flight of white and yellow butterflies . . . which continued to pass for many days successively" in a southeasterly direction. Werneburg, quoting from *Das Ausland* (1872, 68), says that in Venezuela one year in June and July a throng of different species of *Callidryas* moved in a northerly direction out to sea for many days together between 11 A. M. and 2 P. M.

Distant gives a similar account of the related Old World species of *Catopsilia*. A pseudonymous writer, he says, mentions how they

are sometimes seized with a mania for migrating to the far West. . . I have stood near one of the parade-grounds at Poona, and watched them, with scarce a pause to rest their wings or sip a flower, from eight or nine o'clock until the afternoon, as far as eye could reach, the host kept streaming past, like the fugitive Gauls after one of Caesar's great battles. (*Rhop. Mal.*, 286.)

And Mackwood, quoted by the same writer, says of *C. catilla* :—

In the flights along the sea-coast, beginning generally in November, this species of *Catopsilia* forms about a third of the number, always travelling to the north; the flights lasting for days, thousands of them passing in an hour." (*Rhop. Mal.*, 298.)

Werneburg recites the case of a species of *Terias* found flying over the sea in myriads near South Africa at the end of January. But a more detailed and interesting note is that by Rev. Mr. Briggs, cited by Distant (*Rhop. Mal.*, 290) of *Delias dione*. He speaks of it as being

as the "common coasting butterfly," and describes it as being found sometimes in an "apparently endless stream" all following one direction, and numbering twenty to thirty in sight per minute from any one point, but forming a belt several miles broad, extending far inland from the coast, and from morning till night continuing to pass any fixed point for a fortnight or more. "It seems seldom to feed or alight during these migrations, except at night or in early morning, when with dawn it resumes its flight. . . . Now and then it is entangled in a sort of *cul de sac*, formed by thick clumps of fruit trees, or the high walls of houses, against which it will dash itself repeatedly and recklessly, willing to persevere until death. This is especially apt to be the case when a strong head wind is blowing against it." (*Rhop. Mal.*, 290.)

Passing now to the *Pieridi*, we cannot do better than quote the following passage by Thwaites :—

At certain times of the year immense hosts of these butterflies, mostly of a white colour or nearly white, may be observed during the hottest part of the day rushing in an impetuous flight across the country, driven by some irresistible instinctive impulse, and impatient of any obstruction in their headlong course; even ascending hills of 6000 feet in elevation, and descending again; striking like animated snow-flakes against any one meeting them in their course and then, after passing the obstruction, making on with the same pertinacity as before, towards where they are hurrying to, until the failure of sunshine arrests their progress for the day; to be continued probably on succeeding days until the wondrous furor has exhausted itself. By the superstitious natives these marvellous movements of white butterflies are attributed to a desire on the part of the insects to do homage to the footstep of Buddha on Adam's Peak, moved, as the native himself is to do so at certain times of the year.

... I should remark that amongst the main body of these travelling white butterflies, small groups of half-a-dozen individuals or more, may be observed, which in strings of sequence, looking as if playing "follow my leader," have a pretty appearance. In some portions of the country in their line of flight, where shallow water may be lying, large numbers of these white butterflies may be seen quenching their thirst on the damp ground, and flying up when disturbed, in quite a startling cloud. (Moore, Lep. Ceylon, 1: 116-117.)

Tennant in his Ceylon also tells of "flights of these delicate creatures, generally of a white or pale yellow hue, apparently miles in breadth, and of such prodigious extension as to occupy hours and even days, uninterruptedly in their passage." Spruce also tells of a "vast multitude of butterflies" of "common white and orange yellow species," flying to the S. S. E. across the Amazon at right angles to the wind in November, 1849.

Mackwood (Moore, Butt. Ceylon) states that the species of *Catopha* take part in the "large annual flights" of butterflies in the early months of the year, a few weeks after which *C. lankapura* may "be found congregated on damp spots in the open sunshine in great numbers; I have seen quite one hundred within the diameter of twelve inches."

The immense numbers of *Aporia crataegi* of Europe which at Easter, 1829, made the thorn trees on the promenade at Erfurt look as if hung with white blossoms has been related by Keferstein; and the sudden outburst of *Neophasia menapia* in Washington Territory in 1882 was, according to Hagen, "wonderful and indeed only to be compared with an irruption."

But besides this mere thronging found in the temperate zone, there are known examples among the Pieridi of actual migrations. The late Mr. W. W. Hill of Albany spent the month of April 1884 on the Indian River, Florida, and wrote me concerning the movements of *Ascia monuste* :—

During the last ten days of my stay there I observed that *Pieris monuste* seemed impelled to move southward. At first there were but few of them to be seen but their numbers steadily increased until at the end of ten days, when the time came for me to make my departure, many hundreds could be seen at any one time during the day, when not stopping momentarily at some bed of flowers, moving in one direction. If obstructions were encountered, these butterflies flew over or around them and kept on in the same southerly direction.

We have also already recorded (p. 378) a flight of *Pieris rapae*, and others might be given from the collections made by Cornelius, Keferstein and Werneburg. Its near ally and fellow vagrant of Europe, *Manicium brassicae*, has also been noticed moving in streams as it were; thus F. Schmidt crossed a swarm in flight on a calm day and estimated that it was a kilometer wide moving in a southerly direction away from the sea near which the observation was made; on enquiry of others he learned that it had lasted all day and had been seen from a vessel seven and eight miles from land, having, he conjectured, come from an island to the north.

Quite similar swarms of this species have often been observed and it will be sufficient herein to refer the reader to the tables of Werneburg and the more detailed accounts by Keferstein.

The only instances of butterfly migrations belonging to other groups than those I have mentioned are two collected by Werneburg; one is a Lycaenid, the other a Papilionid. The first is presumed to be *Chrysophanus hippothoe* of Europe, which on June 1, 1860, in the valley of Vigor in southern France, flew in a northerly direction in immense crowds in more or less numerous bands from 10 A. M. till evening; all were males. The other is where more than twenty individuals of *Menelaides hector* were seen together two hundred miles from land between the islands of St. Paul and Ceylon.

In studying the movements of *Anosia plexippus*, which have been fully detailed under that species, I have been led to the conclusion that this butterfly makes periodic movements as regularly as the birds. The regularly recurring movements of other butterflies leads me to think that were observations made with more care and continuity, similar conclusions would be reached in other instances. I commend especially to those who are sceptical on this point, the following statement:—

Dr. Karl Fritsch, a Vienna naturalist who has given special attention to field observations upon the seasons of insects, is inclined to believe that in 1879, when *Vanessa cardui* was extraordinarily abundant all over Europe, its movements could be compared to those of summer visitors among the birds, moving north in the spring and south in the autumn. Dr. Katter had summed up the earlier observations of this year in the statement that the butterflies probably crossed the Mediterranean from northern Africa, and from Sicily and Spain spread over Europe. Dr. Fritsch therefore stationed himself in his garden, which had a fair outlook, for several hours every day, near noon, from early in July to near the end of October, and, by observing and noting the direction taken in flight by every single specimen, discovered that there was no prevailing direction until August 26, when, and until October 20, with few exceptions, the prevailing movement was towards the west-south-west and south, or diametrically opposite to the prevailing movements of the swarms in June.

Here, then, the return movement of butterflies, the apparent absence of which so perplexed Mr. Belt, was by careful and minute observations made clear. It is in no way improbable that it is a regular and permanent feature of all migrations among butterflies. In this instance the collective movement was in the spring, the individual movement in the autumn; in *Anosia plexippus* the case is exactly reversed. Why may there not in many cases be individual movement at *both* seasons, which has been overlooked for want of just such careful observations?

EUREMA LISA.—The little sulphur.

[The little sulphur (Seudder); little bordered yellow butterfly (Maynard); little yellow butterfly (Abbot).]

Xanthidia lisa Boisd.-LeC., Lép. Amér. sept., 53-55, pl. 19, figs. 4-7 (1830).

Terias lisa Boisd., Spec. gén. Lép., 1:661-662, pl. 2, figs. 5, 5 (1836);—Morr., Syn. Lep. N. Amer., 34 (1862);—Jones, Psyche, 1:121-125 (1855);—French, Rep. Ins. Ill., vii:148 (1878); Butt. east. U. S., 139 (1886);—Fern., Butt. Me., 34-35 (1884);—Mayn., Butt. N. E., 45-46, pl. 5, figs. 60, 60a (1886).

Eurema lisa Kirb., Syn. catal. Lep., 443 (1871);—Gundl., Ent. Cub., 89-90 (1882).

Pteris similax God., Encycl. méth., ix:166, 136 (1819).

Terias sulphurina Poey., Mem. hist. nat.

Cuba, 1:248-249, pl. 18, fig. 1-3 (1853).

Terias delia Seudd., Proc. Ess. Inst., III:162 (1863);—Mayn., Butt. N. E., 46, pl. 8, fig. 61, 61a (1886).

Papilio parvus luteus Seligm., Samml. auct. vög., viii, pl. 96 (1773).

Papilio ——— Abb., Draw. Ins. Ga. Brit. Mus., vi:16, figs. 63-71 (ca. 1890).

Figured also by Abbot, Draw. Ins. Ga., Oenler Coll. Bost. soc. nat. hist., 3;—Glover, Ill. N. A. Lep., pl. 32, fig. 4; pl. A. fig. 5; pl. N, fig. 6 (ined.).

[Not *Pteris similax* Donovan nor *Papilio delia* Cram.]

Thy citron-yellow wings are bright,
And soft the rosy fringe they wear,
And rays of gloom and silver bright
Adorn thee, blossom of the air!
The Cassia, on whose silken flower
Thy fragile life its being fills,
What hast thou garnered of its dower
To wait thee where thy spirit wills?

LACRA F. HINSDALE.—*Terias lisa*.

Shall I compare thee to a summer's day?
Thou art more lovely and more temperate.

SHAKESPEARE.—*Sonnet*.

Imago (7:4, 5; 15:6). Head covered above with blackish brown scales, enlivened by pretty long, ferrugineo-orange hairs or long, slender scales, especially around the edges of the eyes and in a V-shaped line directed backward, having its angle between the antennae; on either side in front, between the base of the antennae and the tip of the erect palpi, is a thick, greatly elevated cluster of scales, the opposite ones united above and thus forming in front a semi-infundibuliform cavity; the exterior scales are yellow, occasionally slightly tinged with orange, the interior ones orange red mingled with black, and the apical and superior ones mostly blackish brown. Antennae blackish brown, the inner, upper and lower sides with inverted, triangular, white patches at the tip of each joint, which become united on the inner lower edge and form a nearly continuous white line, widening at the tip of each joint, leaving only the outer upper edge free of white scales; generally the upper surface of the whole club is orange, dusky along the middle; under surface orange only at the tip, including two or three joints, but in the amount and position of the orange, there is considerable difference. Palpi at base covered with long, silvery white scales, the exterior ones tinged very slightly with greenish yellow; beyond they become more and more tinged with yellow and above they are quite yellow, the tip and to some extent the upper half of the front enlivened with orange; sometimes nearly all the exterior surface is tinged with orange; lower portion of sides of head yellow. Tongue pale fusco-luteous, pale luteous at base.

Prothoracic lobes furnished with long, forward curving, ferrugineo-orange scales or hairs overarched the head; rest of thorax covered above with long, delicate, greenish yellow hairs; patagia with a tuft of bright yellow scales at the base, the remainder with blackish brown scales mainly concealed by long, greenish yellow hairs; thorax covered beneath with canary yellow scales and no hairs. Legs very pale yellow, the

base of the femora slightly fuscous, covered with yellow scales, the terminal tarsal joints slightly infuscated; spurs pale, tipped with dark red; claws blackish.

Wings above canary yellow, slightly paler and sometimes duller in the female. Basal half of the costal border of the *fore wings*, especially in the female, broadly sprinkled with (mostly concealed) blackish brown scales, the apex with a broad patch of blackish brown, the inner border of which starts from the costal border, at about three-fifths the distance from the base and extends in a concave curve, with two or three waves on the lower half, as far as the lower median nervule, where it is of the breadth of an interspace, and either terminates abruptly (♀), or continues, of the same width as here, to the inner border (♂); a slender black cross line marks the extremity of the cell, sometimes reduced to a mere point; apical half of the costal border, in the female, dull whitish, interrupted with dark brown at the nervure tips; the nervures crossing the dark field are black and the outer margin is marked by a black line, beyond which the basal half of the fringe is dark brown and the apical half ferrugineo-roseate; fringe of the inner margin yellow. *Hind wings* with a few black scales at the extreme base and the rest of the wing immaculate excepting next the outer border, where it either has a bordering of blackish brown, commencing at the costal border in the middle of the costo-subcostal interspace, as broad as an interspace as far as the middle of the lowest subcostal interspace, where it suddenly diminishes one-half in width and then, narrowing gradually but constantly, passes as far as the tip of the lowest median nervule, slightly dentate at all the nervures and ending in a mere line (♂); or, the band is reduced to a series of blotches, the upper a large one, generally occupying only the extremity of the upper subcostal interspace and the adjacent portions of the adjoining ones, the others short streaks, largest apically, surmounting the tips of the subcostal and median nervules (♀); occasionally, in the latter sex, these markings are more or less united, so as to assimilate the bordering to that of the male, but in such case the interior border of the black markings is powdery, while it is well defined in the male; fringe in general the same as in the fore wings, but, in the subcostal area, the outer half is pale yellow, interrupted narrowly at the nervule tips with ferrugineo-roseate.

Beneath slightly duller than the upper surface, the inner border of the hind wings whitish; the upper half of the fore wings very sparsely, the whole of the hind wings sparsely, ornamented with rather dark brown scales clustered, on the hind wings, into more or less distinct, but always powdery spots, which are often accompanied by pale scales and surrounded by yellow ones, slightly tinged with orange; they are transversely placed and situated a little beyond the middle of the lower subcostal, the median and medio-submedian interspaces and a little before the middle of the subcosto-median interspace; the extremities of the nervules in each wing are tipped with black and the upper outer angle of the cell has a minute, blackish, roundish spot; on the hind wings there is also a minute cluster of black scales just above the costal nervure, close to the base, another as near its tip and just beneath the latter, on the succeeding interspace, is a slight transverse cluster of blackish scales; directly beneath the tip of the upper subcostal nervule of the hind wings and crossing the upper and a portion of the succeeding subcostal interspace is a large roundish spot, occasionally reduced nearly to a dot, of a reddish chocolate color, only the upper outer border of which touches the border and the centre of which is enlivened with pale roseate scales; the costal border of the fore wings and the outer border of both is reddish orange, including, between it and the fringe, the black spots at the nervule tips; the extreme base of the fringe and the costal edge are gray and the outer portion of the fringe ferrugineo-orange, excepting on the subcostal area of the hind wings, where it is greenish yellow, tipped with ferrugineo-roseate, and on the inner margin, where it is yellowish.

Abdomen above blackish brown, on the sides bright yellow, with occasional brownish scales and particularly with a broken lateral line of dark scales; beneath white, tinged occasionally with yellow. Upper organ of male appendages (35: 11-13) curved downward, its point reaching the middle of the lower border of the claspers, about

three times as long as high. Clasps of about equal length and breadth, the upper margin bearing near the slightly inturned apical tooth a similar but sharper dentation; not far removed from it and near the middle of the border a slight rounded expansion from which springs a slightly curved, delicate, aculiform spine directed inward; lower border with an inturned pointed spine just before the extremity and similar to that before the tip of the upper border, and, between the two and forming a quadrilateral with them and the apical tooth, another similar spine.

Measurements in millimetres. Length of tongue, 5.75 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	15.5	16.5	18.5	15.75	17.	19.25
antennae.....	6.25	6.1	7.	5.9	6.	6.9
hind tibiae and tarsi..	4.5	4.75	5.25	4.75	5.	5.5
fore tibiae and tarsi..	3.1	3.	3.4	3.2	3.2	3.2

Described from 20 ♂, 17 ♀.

Dimorphic forms. *EUREMA LISA ALBA* (*Terias lisa ab. a. alba* Streck., Cat. Amer. Macrolep., 85). The above description applies to the normal form, *T. l. lisa*. Affecting the female sex only, nowhere exclusively, and perhaps confined to the later broods of the season and to southern localities is the white form first noted by Boll. Above it is very pale, one before me having the yellow wholly replaced by white, with scarcely a trace of brighter color; beneath, however, there is considerable yellow, especially near the base and apex of the fore wings, but here also paler than in the other form. Several specimens were taken by me on the coast of South Carolina in September.

Egg (65:32). Distinctly tapering above only in the middle third, below in the middle fourth; vertical ribs from thirty to forty in number in the middle, decreasing to less than half as many at tip; interspaces very minutely and densely punctulate, the vertical ribs about .025 mm. apart. Color pale green or straw yellow. Height, 1.1 mm.; breadth, .34 mm.; breadth at summit, .08 mm.

Caterpillar. *First stage.* Head uniform, very pale yellowish green, the hairs black; ocelli brown; mouth parts tinged with pink. Body pale green, the first thoracic segment and the last three or four abdominal segments, especially the former, very pale green, as are also the under surface, legs and prolegs, which have a tinge of yellowish; a darker green, slender dorsal thread; papillae concolorous, hairs black, very slightly curved, as long as the segments, excepting on the first two thoracic and last two abdominal segments, where they are half as long again and more arching, those of the first thoracic segment longest and most arching. Spiracles concolorous. Length at birth, 2 mm.; width of head, .2 mm.

Second stage. Head uniform green, with sparsely scattered black bristles. Body grass green; dark green dorsal and infralateral stripes and a faint, greenish yellow stigmatal stripe; the whole upper surface of body above the lateral line and excluding the dark dorsal line with a slight hoary look, but not so light green as the pale green papillae with which the body is covered; these are rather broader than high, well rounded, are arranged in a transverse row on each section, and bear equal bristles, some black, some green, all globule-tipped and of varying but definite lengths. Legs and prolegs green, spiracles concolorous. Length, 4.2 mm.; breadth of head, .8 mm.

Last stage (76:3). Head (79:55) uniformly grass-green; the papillae ivory-white hairs black or blackish brown; ocelli ringed basally with fuscous; mouth parts green; the mandibles reddish fuscous at the edge. Body of the same green as the head; a delicate dark green dorsal line marking the position of the dorsal vessel; the sides deepening in color slowly below toward the stigmatal line, which is a pallid, almost white stripe of moderate breadth; it is rendered more distinct by the depth of the green directly beneath it, which again fades out gradually to the pale green of the under surface; the papillae ivory-white, on the sides of the body more or less annulate at the base with blackish fuscous; all the hairs, both long and short, blackish brown, excepting

on the under surface, where they are pale. Surface of the body finely punctate. Spiracles of the color of the stigmatal band. Legs and prolegs of the color of the under surface, the claws scarcely infuscated. Length, 18 mm.; breadth of head, 1.8 mm.; breadth of body, 2.5 mm.

Chrysalis (84:56). Translucent green, the upper half with a bluish tinge, which sometimes is wanting on the outer sides of the abdominal segments, and sometimes encroaches more or less upon the whole of the under surface, where, however, it is never so distinct as above; the frontal tubercle varying from pallid to fuliginous, generally considerably darker below than above; lateral carina of the wings often more or less pallid, sometimes rendered more distinct by a slightly darker edging above; basal wing tubercle marked by pallid or ivory white, frequently intensified by being in an infumated blotch. Surface of body generally smooth, but the entire surface of the wings and of the head vermiculate, the creases often more or less infuscated, but generally to a very slight extent. The body in general may appear almost destitute of any markings, but even the clearest specimens show a lateral series of black dots just in advance of the middle of the third to the eighth abdominal segments, and a sprinkling of even finer black dots all over the ventral surface of the abdomen and the outermost portions of the dorsal surface; but generally the markings are much heavier, the dots of the lateral series become double and sometimes confluent, and extend even as far as the mesothorax. The prothorax is dotted on the anterior half away from the middle with blackish fuscous specks, and there is besides a series of laterodorsal spots on all the thoracic and abdominal segments, the abdominal segments, at least on the front half of the abdomen, including three spots, the anterior the innermost. Besides this there is often seen a fuliginous blotch on a pallid ground, just in advance of and above the spiracle of the fourth abdominal segment; black dots follow the outer margin of the wing, in each of the interspaces, with series of dots round the nervures, at tolerably regular intervals; at the same time the sprinkling of black dots upon the ventral segments may considerably increase and extend upon the dorsal surface to a much greater extent than in the clearest specimens; a fuliginous dorsal line, including a mediodorsal, pallid thread, often follows the thoracic segments, and the head is marked at its extreme base, dorsally, with fuliginous spots. The girth crosses the middle of the first abdominal segment. Length of body, 15.5 mm.; greatest height at the wing cases, 4.5 mm.; width, 3.4 mm.

Geographical distribution (26:2). This little butterfly is a characteristic member of the Carolinian fauna where it is very abundant. It is found from the Atlantic to the Great Plains in Iowa and Kansas, and south of the loftier Rocky Mountains extends through Arizona to the Pacific Ocean next the boundary line between California and Mexico. To the south it occurs to the very limits of our territory from Atlantic to Pacific, having been found at Florida Keys (Burgess, Palmer, Maynard), southern Texas (Aaron, Lintner) and extreme southern California (H. Edwards). It extends even beyond this, to Cuba (Gundlach) and also, according to this writer, to Jamaica and Porto Rico. On the continent itself it extends through Mexico, Rio Verde (Palmer) to Honduras (Reakirt). It is one of the exceedingly few butterflies found at Bermuda (Jones). It has been reported from Missouri (Museum Comparative Zoology), Kansas (Snow), Illinois (Riley, Doubleday, Michigan University). It extends beyond the northern limit of the Carolinian fauna, having been found in Wisconsin as far north as Racine where it is common (Hoy), in central Iowa at Ames (Osborn), at Rockport "among the most rare species" (Kirtland)

and Cleveland, Ohio (Kirkpatrick), Buffalo, N. Y. (Fischer), New Jersey (Andrews), Yonkers (Lintner), Long Island (Graef, Smith, Akhurst), and Staten Island, N. Y. (Davis). It has occurred occasionally in Ontario, Canada, at Port Stanley and London (Saunders), and Hamilton (Moffatt).

In New England it is found in abundance only in the extreme south, where it may be met with along the entire shore of Long Island, Rhode Island, and Cape Cod and on the outlying islands. It has been taken at New Haven "quite abundant" (Smith), Suffield (Dimmock), and Farmington, Conn. (Norton); Cape Cod (Fish, Seudder), Nantucket tolerably common (Seudder), vicinity of Boston (Shurtleff, Minot, Sprague, Beal, Seudder), and Sunderland (Sprague), as well as in several Massachusetts localities in the Connecticut Valley such as Springfield, South Hadley, Holyoke, Granby, Montague (Dimmock, Sprague, Emery, Seudder); a single specimen has been taken at the Isles of Shoals, N. H. by Mr. Roland Thaxter; and even one in excellent condition at Mt. Desert, Me., by the same entomologist in August, 1880.

Haunts and abundance. Like the *Eurymi*, the butterfly is found in the open country, in gardens, meadows, on the edge of thickets, and around spots of damp earth where it may suck up the moisture. Abbot says in one of his notes that it "settles so many together at times to suck moist places that I have seen twenty in the compass of a hat"; but the most extraordinary statement is that of Jones (Psyche, i: 121-125), concerning an immense flight of these butterflies across hundreds of miles of ocean from the American coast to Bermuda:—

Thus it was. Early in the morning of the first day of October last year (1874), several persons living on the north side of the main island perceived, as they thought, a cloud coming over from the north west, which drew nearer and nearer to the shore, on reaching which it divided into two parts, one of which went eastward, and the other westward, gradually falling upon the land. They were not long in ascertaining that what they had taken for a cloud was an immense concourse of small yellow butterflies (*Terias lisa* Boisdu.), which flitted about all the open grassy patches and cultivated grounds in a lazy manner, as if fatigued after their long voyage over the deep. Fishermen out near the reefs, some few miles to the north of the islands, very early that morning, stated that numbers of these insects fell upon their boats, literally covering them. They did not stay long upon the islands, however, only a few days, but during that time thousands must have fallen victims to the vigorous appetites of the blue bird (*Sialia sialis* Baird) and black bird (*Mimus carolinensis* Gray), which were continually preying upon them. Only one other instance of a flight of these butterflies visiting the islands is recorded (in the author's "Naturalist in Bermuda" p. 120). . . .

The question, therefore, naturally arises—How did this immense concourse of butterflies get to the Bermudas? The nearest point of land is Cape Hatteras, in North Carolina, which is somewhere about 600 miles distant, and if they had started from this point and taken a straight line to the islands, without meeting with any contrary winds, it would, at the rate of 12 miles per hour (a fair average rate of travel for any of the Pieridae), have taken them two days and two hours (of course including nights) to complete the distance; a space of time almost too great, we should imagine, for an insect in no degree remarkable for robust frame or strength of wing to keep up a

continuous flight. We are, however, inclined to think that the presence of this vast concourse of insects at the Bermudas was not owing to ordinary causes, and that we must look to some extraordinary means to solve the mystery. From a very extended series of observations . . . we have become impressed with the fact that the largest flights of birds occur there during the period of great atmospheric disturbance. From the latter end of September to that of October, violent revolving gales are prevalent throughout the region which comprises the east coast of the southern and middle states and the North Atlantic in those latitudes, for some 600 or 800 miles from land [which might engulf large numbers of these butterflies] . . . Hurlled with amazing rapidity along this cool aerial current, in the course of about three or four hours the heated vapor arising from the Gulf Stream would be met with, and would it be considered as too imaginative to grant that the ascending warmth of that stream has power sufficient to ameliorate the condition of the cool current, to stay its rapid course and allow the animal freight to descend, which, then within a comparatively short distance of the Bermudas, would seek the nearest land, . . . and aided perhaps by perfect calm or favorable breeze, arrive at those distant isles, without encountering the dangers, which, in the form of contrary winds, would most certainly accompany an intentional migration to the islands?

Oviposition. Eggs sent me by Miss Eliot were laid, some on the stem, some on the upper surface of the leaf of the food plant. They hatch, in New England, in the latter part of the season, in five or six days; thus some, laid "on or about August 7 or 8," hatched in the night of August 14-15; others, laid August 18-19, hatched in the night of August 25-26; and others, laid August 19 and 20, hatched August 25 and 26.

Food plants. Dr. A. W. Chapman reared the caterpillar many years ago on partridge pea, *Cassia chamaecrista* Linn. Abbot states in his notes that it feeds on *C. occidentalis* Linn., but is "more frequent" on *C. chamaecrista*; Miss Eliot obtained the eggs freely from butterflies caged on the same, and I reared them easily on plants repeatedly sent me for the purpose from New Bedford by Miss Eliot. Edwards tells me that he fed on *C. nictitans* Missouri specimens sent him, and it is this plant and not *C. chamaecrista*, which grows in great beds in the railway cutting north of Holyoke, where the butterfly is always found; I cut off at the root, however, and examined inch by inch some hundred plants on the spot one mid-September day in a vain search for egg or larva. Boisduval and LeConte state that it feeds on various species of *Trifolium* and *Glycine*, as well as *Cassia*, but I am inclined to doubt it, for before Miss Eliot sent me plants from New Bedford, I lost specimens by not getting food to their liking. I did not try either of these genera, but the young caterpillars utterly refused *Cassia marylandica*, and rather than eat *Desmodium* or *Coronilla*, preferred the entirely dry leaves of *Cassia chamaecrista*. One, indeed, ate some *Coronilla* and filled himself green with it, and passed half a dozen pellets of excrements, but would touch no more of it. Another to escape hung himself from a *Coronilla* leaf by a thread at least two inches long. Another experimented with *Desmodium*, and ate the parenchyma of the upper surface in two or three minute holes, indicating, perhaps, the number of meals it had made, but died on the fresh leaf with-

out stirring from the spot. Others would not touch either. I conclude, therefore, that *Cassia* alone is the food plant of the larva, and that it has a decided preference for the species with small and finely divided leaflets.

Habits of the caterpillar. After escaping from the egg, the little caterpillar generally continues to eat some of the shell it is leaving, and sometimes devours nearly the whole of it. From the very first it feeds on the under side of the leaves, and eats long, parallel and narrow holes entirely through between the veinlets, after the manner of *Eurymus*. As the leaflets of the food plant close at night, this position would seem to be a necessary one, and also probably induces a habit of feeding only by day.

When not feeding, the caterpillar invariably stretches itself out at full length, either along the stalk of the plant or the middle rib of one of the leaflets, where, being of the same color as they, and the stigmatal stripe resembling in its straightness and stiffness the midrib of the leaflets themselves, its detection is very difficult. When disturbed, it will raise the front portion of the body barely above the surface, and sway it from side to side in a slow but deprecatory manner; but if roughly handled, it will drop from the leaf, spinning a thread and hanging thereby.

In preparing for chrysalis, the loop for suspension is found in the incisure between the second and third abdominal segments; but in the chrysalis it always crosses the middle of the first abdominal segment.

Life history. The life history of this insect is very obscure and puzzling. I have tried to translate the facts known from the south by our northern experience, and reversed the process only to find fresh difficulties. The principal difficulty is to understand how it passes the winter. In Florida it flies nearly the year around, from early in February to late in November. Early in the spring, however, the butterflies are so few in number, until the end of April, that one might take them to be individuals which had passed the winter in the winged state; and the behavior of the insect in the north, and the probably similar habit in *Xanthidia nicippe* renders this the more probable. In May, at any rate, a new and fresh brood appears and by the end of the month becomes numerous, and thereafter remains so. Fresh material appears to arrive toward the end of July (Dr. Chapman bred one from chrysalis, August 2), and again from and after the middle of September (Abbot bred it September 13), and very fresh specimens may still be obtained in Georgia to the end of October. This would give three broods a year, counting the spring butterflies as a part of the September-October brood, though certainly some of the specimens I have seen collected in March seemed fresh enough.

North of Pennsylvania, or on the northern edge of its range, I cannot learn that the butterfly has ever been seen earlier in the spring than the middle of June; June 12 at Mattapan, near Boston, is the earliest, and the specimen was noted as good. The brood which this marks flies only

in very scanty numbers, and to the middle or end of July; immediately thereafter, or early in August, generally from the 2d to the 5th, a new brood appears which is much more numerous, sometimes tolerably common, and butterflies continue to emerge from the chrysalis, judging by the capture of perfectly fresh specimens, well into September and to fly throughout the month. No October captures have been noted. The eggs are laid certainly as late as August 18-20, when Miss Eliot obtained them, and I have had females with fully developed eggs none of which had been laid, as late as September 9. The eggs hatch in about six days and the caterpillars are full fed in about a month from the time the eggs are laid. And now follows the strange part of the procedure at the north. All my chrysalids in the autumn of 1888, which entered that state between the 17th and 22d of September, and were kept in an unheated room adjoining a very large one heated only by an open wood fire, and where the windows were kept open night and day, gave out imagoes; the first change of coloration was noticed between October 11 and 15, and in this condition of partial readiness they remained from seven to thirteen days, and finally emerged October 18-27 after from thirty to thirty-eight days in the chrysalis. Of course this is not normal, but the conditions of temperature must have been very slightly different from what they would have had in the open air. Of two specimens which changed to chrysalis in the night of September 18-19, one emerged October 21; the other was sent to Mr. Fletcher in Ottawa, and reached perfect maturity on November 4, but failed to emerge. This appears to me to be an attempt in the north to simulate the third brood in the south, but it scarcely seems possible that the earliest produce of the second brood can reach maturity in season out of doors to give birth to imagoes before such cold and frosty nights would come as would kill the newly emerged butterflies. Still it would appear that it is probably by this small chance of life that the butterfly maintains its foothold in the warmer nooks of New England.

Flight and postures. Its flight is much more vigorous than one would anticipate from its appearance, but is after all feeble and timid, as becomes such a weak winged creature. It has none of the hurried zigzag movement of *Eurymus*, and flies but short distances at a time close to the ground. It will fly in the windiest and most heavily clouded weather.

When alighted but alert, the wings are closed, the front pair erect, their costal edges at scarcely less than a right angle with the axis of the body, the antennae arcuate and extended on a general plane with the body, the club drooping, and divaricate about 80°.

When at complete rest, the fore wings are dropped back so as to bring the costal edges of all the wings nearly parallel except at tip, the costal edge of the hind wings exactly fitting, at base, the lower edge of the costal vein of the fore wings; the antennae are held as above, but only divaricate

about 30°. At rest for the night on a vertical surface, the wings were observed after dark to be back to back, all the costal edges together, the antennae thrust in front, drooping a little from the axis of the body, the club curved downward from that line, the two antennae touching, except at the extreme tip.

Enemies. The only parasite known to attack the insect is *Pteromalus puparum* (89: 1, 2), which Mr. Riley reared at the end of February, from infested pupae sent him by Mr. Mundt of Illinois. Mr. Jones, however, in the passage quoted above, says that the butterflies were continually preyed on in Bermuda by the bluebird, *Sialia sialis*, and the cat bird, *Galeoscoptes carolinensis*.

Desiderata. It will readily appear from what has been related of the life history above, that there are many points in which it needs to be cleared up. Especially is it desirable to learn how the insect passes the winter, by independent observations in the north and in the south. If all the September caterpillars in New England go on to chrysalis and even to imago, how is the species kept up? for surely the butterfly cannot emerge in October and hibernate in our climate; and if it hibernates as a chrysalis, or even as a mature or nearly mature caterpillar, why do we see butterflies no earlier than the middle of June, when butterflies in the south make their appearance in the very earliest days of spring? What is the meaning of the long delay of the butterfly when the chrysalis has begun to change? And why does each brood of butterflies appear to linger on the scene so long by the accession of new material? What is the reason for the unusual barrenness in numbers of the spring brood? How many broods are there in the south?

LIST OF ILLUSTRATIONS.—EUREMA LISA.

General.

- Pl. 26, fig. 2. Distribution in North America.
89: 1. *Pteromalus puparum*, ♂; a parasite.
2. *Pteromalus puparum*, ♀.

Egg.

- Pl. 65, fig. 32. Plain.

Caterpillar.

- Pl. 76, fig. 3. Full grown caterpillar.
79: 55. Head, fifth stage.

Chrysalis.

- Pl. 84, fig. 56. Side view.

Imago.

- Pl. 7, fig. 4, 5. Males, both surfaces.
15: 6. Female, upper surface.
35: 11, 12, 13. Male abdominal appendages.
40: 4. Neuration.
56: 3. Side view of head and appendages enlarged, and details of leg structure.

EURYMUS SWAINSON.

Eurymus Swains., Horst., Descr. ent. Lep. E. Collas Auctorum.
Ind. mus., 129, 134 (1829).

Type.—*Papilio hyale* Linn.

Whole tribes of yellow butterflies
Dart mockingly and wheel and soar,
Making it only seem the more
Impossible, this human death which lies
Silent beneath their dance who live
One day and die.

H. H.—*A Funeral March.*

Imago (56:2). Head rather large, thickly clothed with very long, erect hairs, longest on the front and toward the middle. Front a little and rather abruptly protuberant down the middle, especially below where it surpasses a little the front of the eyes; elsewhere nearly flat, with one or two longitudinal ridges on either side, especially below, low and insignificant; between the antennal pits a longitudinal sulcation, deepest and broadest behind, separating into two diverging halves that portion of the front which stretches rather broadly between the antennae; as broad as high and nearly as broad as the eyes on a front view, the sides diverging upward a little; upper border scarcely rounded off next the antennae; lower border squarely docked. Vertex broadly and gently tumid in the middle and a little so at either side, especially above, where, at the produced projecting angles, it is slightly protuberant; anterior border a little sinuous, elevated along its entire length above the parts in front, rounded off in the middle, abrupt at the sides. Eyes not angulated next the antennae, large, full, naked. Antennae inserted slightly in advance of the middle of the summit in distinct, deep pits, open toward the eyes and separated from each other by the width of the basal joint; no longer than the abdomen, consisting of about thirty joints, of which the last nine or ten form a nearly cylindrical club, which is two and a half times as thick as the stalk and nearly or quite five times as long as broad; it increases very gradually in size, attains its maximum in the middle of the apical half and decreases, as gradually, to the terminal joint, which is large, very broadly rounded, almost abruptly docked; down the middle of the under surface, the middle of each joint has a shallow, circular or longitudinally oval depression or dimple. Palpi not very long, pretty stout, tapering on the apical half, rather more than half as long again as the eye, the apical joint minute, the middle joint of the same length as the basal, all clothed abundantly with scales and furnished beneath with a thin fringe of not very long hairs, directed downward and a little forward.

Prothoracic lobes, viewed from above, very minute, subglobular, a little appressed, not so broad as the club of the antennae, placed obliquely; viewed from the front, short fabiform, half as broad again as high, nearly as long as high. Patagia of medium size, long and rather slender, a little arched, scarcely tumid, more than three times as long as broad, the outer border nearly straight, the inner border, largely arched at the base so that the posterior lobe, occupying the apical half, is scarcely half so broad as the base, nearly equal, the tip bluntly rounded.

Fore wings (40:11) from two-thirds to more than three-fourths as long again as broad, the costal margin a little convex on the basal third, beyond straight or scarcely concave, toward the tip again a little rounded, the apical angle bluntly rounded; outer margin with the upper third slightly rounded, below nearly or quite straight, sometimes scarcely concave in the middle; inner margin straight or scarcely convex, the outer angle broadly rounded off. Costal nervure terminating at some distance beyond the middle of the costal border; subcostal nervure with three branches; the first arises at the middle of the outer two-thirds (♂, 61:9) or a little beyond the middle (♀, 61:10) of the cell; the second a little (♂) or considerably (♀) beyond the apex of the cell; the third at one-third (♀) or slightly less than one-third (♂) the distance

from the apex of the cell to the outer margin, its upper branch forking at about half way to the tip; * cell a little less than half as long as the wing and scarcely three times as long as broad.

Hind wings with the costal margin well rounded, more strongly on the basal than on the apical half, the outer margin a little full and roundly angulated in the upper part of the subcostal region, especially in the ♀, below broadly and pretty regularly rounded, more convex in the ♂ than in the ♀; inner border broadly expanded at the base, beyond slightly convex, the apical third somewhat excised; the angle rounded broadly. Costal nervure without any branch; vein closing the cell striking the subcostal and median nervures at about equal distances beyond their second divarication.

Fore tibiae a little more than two-thirds as long as the middle tibiae; fore tarsi a little longer than the fore femora and a little shorter than the middle tarsi or still shorter than the hind pair; hind femora two-thirds (♂) or more than three-quarters (♀) the length of the middle pair. Femora fringed rather heavily with long hairs. Tibiae armed beneath on either side with a row of distant, short and very slender spines, with a similar row on each side and at tip a pair of rather short and slender, tapering spurs. First joint of tarsi scarcely shorter than the others combined, the third and fifth equal, the fourth more than half as long as the second, all armed throughout with frequent, short and slender spines, mostly arranged in longitudinal rows; beneath with greater regularity than above, there being four rows, and the apical spines of each joint are a little longer than the others; claws rather large, compressed rather regularly but not greatly curved, somewhat divaricate, bifid for more than half their length, the lower branch shorter than the upper and more curved; paronychia and pulvillus entirely absent.

Eighth abdominal segment produced posteriorly in the male as a rather stout and blunt hook, usually rather strongly curved. Hook of upper organ small, about half as long as the hook of the eighth segment and similar to it, but rather equally curved and tapering regularly to a point. Claspers scarcely one-third as long as broad, broadly, roundly and rather deeply excised on the posterior margin, the upper portion curving inward and bearing posteriorly a slight tooth.

Egg. Rounded subfusiform, largest in the middle, tapering below nearly as much as above, broadly rounded next the summit, which itself is squarely truncate, flat, thickened at the rim; provided with a considerable number of vertical ribs slightly raised and rather delicate, all of which reach the base, but a few, before attaining the summit, unite with their neighbors to form a single rib, and connected by numerous distinct but very delicate raised cross lines. Micropyle rosette occupying nearly the whole summit of the egg, and composed, besides the few oval cells surrounding the centre, of numerous small angular cells.

Caterpillar at birth. Head broadest at the summit, a little broader than high, the sides narrowing a little only in a curve as far as the ocellar field, the part below well and regularly rounded, summit almost square. It is deeply shagreened and furnished both with occasional rather long, tapering hairs and with distant, pellucid, papilla-mounted bristles, like the wine glass shaped ones of the body but longer.

Body of the form of the adult but slenderer than the head, roughened uniformly with multitudinous raised points, armed also with regular rows of slightly elevated small, conical warts, each bearing a very short pellucid bristle, the upper ones infundibuliform or short wine glass shaped, the lower club shaped (86: 42); they are arranged in longitudinal rows as follows: a laterodorsal series, one on the anterior portion of each segment; a supralateral row, one on the posterior part of each segment; a suprastigmatal row, one in the centre of each segment; and a substigmatal row, two on each segment the posterior higher than the anterior. The position of these warts on the thoracic segments is modified, they being arranged on the anterior half of the segments, in a transverse row; the terminal segment has a few long, backward directed hairs; the first thoracic segment bears a transverse row of not very long ones and there

* The second and third subcostal nervures are closely approximated in *E. eurytheme*.

is a ventrostigmatal row of small wart-bearing not very long tapering hairs, one to each segment. Legs rather short and stout, the last joint slenderer, tapering; claw rather small. Prolegs very short indeed, the ventral having seven hooklets arranged on the posterior and inner half of a broad transverse oval, the anal thirteen hooklets around all quarters of a circle excepting the posterior, the hooklets very small, pretty strongly curved, tapering, separated by half the width of the base of one of them.

Mature caterpillar. Head very regularly rounded without fulness in any part, broadest at the upper limit of the ocellar field, well domed above, a little broader than high; of nearly uniform depth, the front appressed a little, the sutures impressed slightly; covered very uniformly and rather abundantly with very minute papillae each giving rise to a short, slightly curving, tapering, erect, delicate hair; triangle less than half as high again as broad, reaching a little above the middle of the front; antennae with the first joint moderately large, conical, the second nearly as long as broad, the third a little smaller than the second, fully twice as long as broad, slightly enlarged at the tip and bearing a long bristle, the fourth minute, conical. Ocelli six in number, four of which are large and prominent and arranged from above downward in a scarcely curving row, its convexity forward and a little downward, the upper three at nearly equal distances apart, about the diameter of one of them, but the upper two slightly nearer, the third slightly nearer the fourth or lowest than the first; the other two, the fifth and sixth, are smaller and less prominent and are situated behind the others, one behind the second and the other above it, so that with the first and third they are placed at the angles of a regular lozenge. Labrum moderately large, not very broadly, pretty deeply notched in front. Mandibles moderately large, not long but quite broad, the edge rudely, coarsely and slightly notched. Maxillary palpi very small, short and stout, the joints of about equal length and of decreasing magnitude, the fourth minute; inner palp very inconspicuous. Spinneret very small, short, conical, finely pointed.

Body cylindrical, larger throughout than the head, though in the second stage it is of the same size as the head, nearly equal, tapering forward a little on the first two thoracic segments and to a greater extent from the sixth abdominal segment backward, the last segment tapering quite rapidly so as to be bluntly conical; in other parts nearly equal. Each segment, excepting the last abdominal, divided by transverse lines into six subequal parts, the eighth abdominal into four, the fifth part, counting from the front, occurring only on the sides of the thoracic segments. In the second stage the segments are each divided by four transverse impressed lines, as distinct as the sutures, into five equal parts. Body covered uniformly and pretty abundantly with minute warts, each giving rise to a single short, delicate, erect, tapering hair. Spiracles ob-ovate, nearly twice as long as broad. Legs prominent, the front pair about half as large as the others, the basal fleshy portion of all very large and protuberant, the whole tapering rapidly and pretty regularly, the apical joint appressed, the claw minute, delicate, slender, compressed, finely pointed, but little curved. Prolegs pretty plump and stout, tapering rapidly, not very long, the pad circlet of the ventral pairs small, with from 20-24 hooklets arranged in a curving double row; the hooklets are rather long, pretty strongly curved, compressed, tapering a very little, bluntly pointed, separated from each other by two or three times their diameter.

Chrysalis. Viewed from above, the anterior part of the body, in front of the basal wing tubercles, is triangular: the base and sides nearly equal, the latter almost straight, a little full over the eye and part of the prothorax, the frontal tubercle forming the apex of the triangle. Over the whole extent of the wings the sides are equal and parallel, very slightly hollowed at the first abdominal segment. Beyond the body tapers, at first gradually, afterwards a little more rapidly. The frontal tubercle is conical, the eyes and the front between them a little protuberant, most noticeable anteriorly, the lower surface as far as the wing tips considerably curved, being swollen just beyond the middle of the wings, behind which the curve is more rapid than in front of it; tongue extending a short way beyond the antennae and both falling considerably short of the tip of the wings, the apical fourth of the lower edge of which meet along the middle line;

the sides of the wing are obliquely compressed, the lower, ventral, swollen part being transversely well rounded, while the field of the other appendages is depressed; thorax somewhat elevated, the mesothorax ridged with a gentle arch, the sides inclined toward each other at scarcely less than a right angle, scarcely swollen, the ridge transversely rounded; the whole abdomen very broadly, gently and regularly arched; the whole side of the body ridged, commencing with the frontal tubercle, passing through the basal wing tubercle and the upper margin of the wing and continuing over the whole of the fourth and succeeding abdominal segments just above the spiracles, to the sides of the cremaster; it is indistinct in front of the wing tubercle, prominent and transversely forming a right angle on the wings, conspicuous but not greatly elevated on the abdomen; basal wing tubercle pretty large and rounded but not greatly elevated. Preanal button scarcely raised above the surface and distinct only by the apical tubercles which are small, approximate, recumbent, anteriorly directed, swollen at base, beyond conical. Cremaster viewed from above tapering considerably, abruptly docked, a little longer than its medium breadth, transversely rounded, with a pair of prominent, strongly compressed, rugulose, equal, parallel ridges, midway between the middle and the sides, extending over the apical two-thirds of the cremaster. Viewed laterally it is slender, tapers a little, is bluntly pointed, curves slightly downward and has the margins raised; the apical field of hooklets is transverse, broadest beneath but not greatly broader than long. Hooklets moderately long, the stem very slender, a little curved, the apical portion bent suddenly over into a nearly circular domed expansion, its general direction at right angles to the stem, the apex produced downward and angulated.

This genus is the only one of the tribe which has its metropolis north of the tropics, and the species are about equally distributed between the Old and New Worlds. In Africa and South America it reappears south of the tropics and is even occasionally found within the tropics themselves, but probably only in elevated regions.* It extends to the high latitudes of the Old World as well as to Greenland and the land lying within the arctic circle in America as far north as butterfly life exists; some of the most northern species are said to be common to both continents. It is not represented in Australia, though a single species occurs in some of the Pacific Islands. In the eastern part of America, south of the colder regions, there are but two common species, one of which is abundant only in the Mississippi valley and westward, the other in the northern Mississippi valley and eastward. The latter is the commonest butterfly of New England and is found throughout its limits; the former has occurred there in a few instances; a third species belonging to Canada has once or twice been found in northern New England.

The butterflies are of medium size for Pierinae, varying from one and one-half to two and a half inches in expanse. They are usually sulphur yellow above but vary from soiled white to deep greenish orange; both sexes of the northern and alpine butterflies and often the females of the temperate species are pale; the outer border of the upper surface is bordered with deep brown, often, especially in the female, enclosing pale

Eurymus "In tropical America is confined to the highest plateaux of Columbia, reappearing in several specific forms in the plains of

the southern temperate zone; no trace whatever of the genus being found in the Amazon valley" (Bates, Journ. of entom., 1861, 230).

spots; the fore wing has a black spot at the tip of the cell above, repeated beneath, with a pale or silvery pupil; and the hind wing has a larger central spot, faint orange or obsolete above, silvery, dark edged and sometimes double beneath; the under surface resembles the upper except in these particulars, in wanting the black border and in being frequently flecked with green. The butterflies may be distinguished from all our other northern *Pierinae* by the absence of *paronychia*.

There is probably not another group of butterflies about the different members of which, at least in this country, there has been more dispute or more varied opinions held. Fortunately for our present consideration these questions hardly arise, the three species here discussed being very certainly distinct, though no doubt nearly allied.

These insects are single brooded in the alpine, arctic and subarctic regions, double brooded in Europe and triple brooded in the United States. The European species are all said to hibernate in the chrysalis state,* while the single brooded forms have been supposed to winter either as eggs or chrysalids. The former is in no degree probable, for the eggs are of such a form and structure as could scarcely brave the perils of winter, and are laid upon the leaves of the food plant. Doubleday says that a few individuals probably hibernate as butterflies, but it is probably upon the endurance of the caterpillar that the existence of the species depends. The caterpillars live singly and mature rapidly, the species of the temperate regions feeding on papilionaceous Leguminosae, while the alpine *E. palaeno* feeds on different species of *Vaccinium* (*Ericaceae*). The butterflies are somewhat swift in flight, especially when alarmed, but they do not usually rise more than three or four feet above the ground. They frequent the open country. The North American species, says Doubleday, are extremely fond of alighting on moist sand or mud. By the side of ponds and brooks, throughout the northern and middle states, and on the large mud holes not very rare in the roads of Ohio and Illinois, I have seen them assembled literally by hundreds. In the northern states it is only *Colias philodice* which occurs, but in the middle and western states the assemblage is composed also of *Colias coesonia*, *Callidryas marcellina*, *Terias nicippe* and *Ter. lisa*. These assembles are so closely packed that rows of forty or fifty individuals may be seen, their wings closed over their backs, their sides actually touching one another. Sometimes the group is augmented by a few noble specimens of *Papilio turnus*, *P. troilus*, *P. philenor* and *P. asterias*, with the addition of some large fritillaries and perhaps that beautiful little blue, *Lycæna comyntas*. These companies, when thus met, are very reluctant to disperse, and are rarely disturbed by a mere passer by. When they do all rise together, the sight is beautiful in the extreme (*Gen. diurn. Lep.*, 1:73).

Sometimes great clouds of these butterflies have been seen on the wing, the most interesting account of which is the one given by Darwin which we have elsewhere quoted.

The eggs are subfusiform in shape, longitudinally ribbed and attached at one end; they hatch in a very short time.

* Long claims that *E. edusa* hibernates as an imago.

The juvenile larvae are furnished on each side of the body with four rows of short, fleshy papillae, expanding from a slender base to a club-shaped apex, as broad at the tip as its entire length; three of these rows are above the spiracles, each bearing one appendage to a segment, and one beneath bearing two appendages.

The mature caterpillars are profusely clothed with minute short hairs, arising from delicate, regularly disposed warts. They are green with a lateral stripe of yellow; the warts are sometimes black.

The chrysalids are straight, but with the wing cases only slightly swollen, the conical frontal tubercle short and blunt; they are generally green with a yellow lateral line.

EXCURSUS XLIII.—COLOR PREFERENCES OF BUTTERFLIES, AND THE ORIGIN OF COLOR IN BUTTERFLIES.

Il était une rose en un jardin fleuri,
Se piquant de régner entre les fleurs nouvelles.
Papillon aux brillantes ailes,
Digne d'être son favori,
Au lever du soleil lui conte son martyre;
Rose rougit et puis soupire.
Ils n'ont pas, comme nous, le temps des longs délais;
Marché fut fait de part et d'autre.
"Je suis à vous, dit-il; moi, je suis toute vôtre."
Ils se jurèrent tous deux d'être unis à jamais.
Le papillon content la quitte pour affaire.
Ne revient que sur le midi:
"Quoi! ce feu sol-disant si vif et si sincère,
Lui dit la rose, est déjà refroidi?
Un siècle s'est passé (c'était trois ou quatre heures)
Sans aucun soin que vous m'avez rendu:
Je vous ai vu, dans ces demeures,
Porter de fleurs en fleurs un amour qui m'est dû.
Ingrat, je vous ai vu baisier la violette,
Entre les fleurs simple grisette,
Où à peine on regarde en ces lieux;
Toute noire qu'elle est, elle a charmé vos yeux.
Vous avez caressé la tulipe insipide,
La jonquille aux pâles couleurs,
La tubéreuse aux malignes odeurs.
Est-ce assez me trahir? Es-tu content, perfide?"
Le petit-maitre Papillon
Répliqua sur le même ton:
"Il vous sied bien, coquette que vous êtes,
De condamner mes petits tours;
Je ne fais que ce que vous faites;
Car j'observais aussi vos volages amours.
Avec quel goût je vous voyais sourire
Au souille caressant de l'amoureux Zéphire!
Je vous passerais celui-là;
Mais, non contente de cela,
Je vous voyais recevoir à merveille
Les soins empressés de l'abeille;
Et puis, après l'abeille, arrive le frelon;
Vous voulez plaire à tous, jusques au moucheron.
Vous ne refusez nul hommage;
Ils sont tous bienvenus, et chacun à son tour."
C'est providence de l'amour
Que coquette trouve un volage.

LAMOTTE-HOUDART.—*La Rose et le Papillon*.

DARWIN has argued, as every one knows, that the beauty of flowers depends very largely, perhaps entirely, upon insects, the purpose of the gaily colored corolla being to attract the insect to the spot necessary for it to

reach to effect fertilization in the plant. The broad fact that flowers fertilized by the wind are never gaily colored, while there are others habitually producing two kinds of flowers, one open, colored and provided with nectar to attract insects, the other closed, uncolored, destitute of nectar and never visited by insects seems to render this very clear. But we still need to know how color originated in the equally or more gaily colored butterflies which visit flowers, which the poets have been wont to compare to flowers afloat. The prevailing opinion has been that this was due in the first instance, as in the case of the birds, to sexual selection, that male being chosen which surpassed in beauty. This is the view held by Darwin; but recent discoveries in physiology and histology make it clear that butterflies have themselves no power of clear vision. They may see masses of color, but not definite pattern or form, and as, apparently, the disposition far more even than the brilliancy of color goes to make up the beauty of butterflies, this can in no sense be looked upon as a true cause.

That butterflies have some perception of color in mass is unquestionable. It has often been remarked that white butterflies alight by preference upon white flowers, yellow butterflies upon yellow flowers. Direct observations have shown that this vague opinion is founded clearly upon fact, and several instances which show this and at the same time show the lack of power of perception of form have been published. Thus Christy observed in Manitoba one of the swallow tails "fluttering over the bushes, evidently in search of flowers. As I watched it," he says, "it settled, momentarily and exactly as if it had mistaken it for a yellow flower, on a twig of *Betula glandulosa* bearing withered leaves of a light yellow color" (Proc. Ent. soc. Lond., 1885, 9). Albert Müller records seeing the blue alexis of Europe fly toward a very small bit of pale blue paper lying upon the grass and stop within an inch or two of it as if to settle, doubtless mistaking it for another of its own kind. Plateau has observed *Aglais urticae* of Europe fly rapidly toward a cluster of artificial flowers, and a species of *Pieris* toward a white calla which could offer it no sweets. And Jenner Wier has noticed how the white butterflies settled on the variegated leaves in his garden.

Such examples as these seem to indicate that butterflies may perceive color in mass but in no case indicate any further visual powers; and since the difference between the sexes is generally rather one of disposition of colors than of variety in the colors themselves, though the latter is by no means wanting, the theory of sexual selection proposed by Darwin cannot be rightly claimed to cover the general ground. Wallace, moreover, has adduced strong reasons for doubting the value of this theory, even in those animals against whose powers of sight no such stricture can be made, believing, as he does, that all differences between the sexes can be explained from the fact of the greater vigor of the male, and the intensity of that

vigor in the breeding season. This theory, too, would at most hardly do more than explain the differences one now finds between the two sexes, and could not take into account, except in a very secondary way, by transmission, that wonderful variety and brilliancy of color found throughout whole groups of butterflies and common to both sexes.

Wallace has pointed out that, in general, color is proportionate to integumentary development, that no insects have such widely expanded wings in proportion to their bodies as butterflies and moths, that in none do the wings vary so much in size and form, and in none are they clothed with such a beautiful coating of scales. In support of the physical theory of the production of color, he maintains that numerous color changes must have developed in such long continued expansion of the membrane,—color changes which have been checked, fixed, utilized or intensified, according to the needs of the animal, by natural selection; and by this alone would he explain all the variety which we find in the whole tribe of butterflies. And this indeed seems to be the best explanation that can be offered, and one that is in better accordance with our knowledge of the distribution of color generally in the animal kingdom, with the heightened colors that we find in the tropics, with other features of the geographical distribution of colors and with that biological distribution throughout great groups in the animal series. Some colors may therefore be looked upon as of great antiquity. The prevalence of yellow and orange in the Rhodoceri, of white in the Pieridi, of white and green and orange in the Anthocharidi, of coerulean blue in the Lycaeninae, of silver spots in the Argynniidi, of browns in the Satyrinae, and of other colors in other groups, all indicate that these colors have in each instance held control during all the changes which have followed the development of these types from a common ancestry.

A very large proportion of the colors and patterns upon the wings of butterflies, far larger, I believe, than is generally conceded, must be looked upon as protective and to have originated in the simplest possible manner through natural selection. Surely if the wonderful mimetic changes we have before recorded have been brought about through natural selection, and that, too, in comparatively recent time, we must allow its power to accomplish very much in the modification and distribution of pattern. It seems in any event probable that we shall have to concede to the same laws of development which have moulded the structure and form of all organized beings, the power to develop that wonderful display of color and pattern on the wings of butterflies which appeals so powerfully to the aesthetic sense of every human being.

Yet plainly natural selection, as such, cannot account for everything in color, any more than it can in structure. Infinite variety and multiplicity of pattern may be due to its action; but what shall we say of infinite har-

mony? of a harmony which appeals to savage and to sage? There has yet to be brought forward one single line of evidence to show that natural selection or any other purely natural, law-constrained force can, uncontrolled, produce or even sustain that harmony of tint and design which each of the whole tribe of butterflies displays on its individual surface; a harmony so infinitely extended when comparisons are begun that the eternities would not suffice to exhaust them; a harmony pervading the utmost minutiae, which the unaided eye cannot perceive; a harmony appealing at every point to the aesthetic sense of the highest creature we know, doubtless also to many a lower one whose physical and psychological acquirements permit it. The untrained child but rarely and accidentally touches a chord upon the piano; so the undirected play of natural forces with color would oftenest be misdirected; and where is the selection that shall bring about the survival and perpetuation of the harmonious? Nay, that has done it! Every part of the animal frame, the entire oeconomy of the animal kingdom, the aesthetics of the animal universe, past and present, point to an infinite and eternal directive force, guiding all forces: to an infinite, uplifting power, which we may trust.

Table of species of Eurymus, based on the egg.

Quadrangular cells between the vertical ribs more than three times as broad as high.....	philodice.
Quadrangular cells between the vertical ribs about twice as broad as high.	
Punctations of surface circular.....	interior.
Punctations of surface long-oval, more or less confluent.....	eurytheme.

Table of species, based on the caterpillar at birth.

Laterodorsal dermal appendages with no stalk, enlarging uniformly from the base, as broad at tip as high.	
Apical enlargement of dermal appendages in the neighborhood of the stigmata much longer than broad and pedicelled.....	interior.
Apical enlargement of dermal appendages in the neighborhood of the stigmata of equal length and breadth, sessile.....	philodice.
Laterodorsal dermal appendages with a short stalk, the enlarged portion as broad at tip as high, and twice as long as the stalk.....	eurytheme.

Table of species, based on the mature caterpillar.

Darker color following the under edge of the pale stigmatal stripe collected into distinct velvety black dashes in the middle of most of the segments.....	philodice.
Darker color below the stigmatal band generally almost equally distributed, or at the most forming only obscure blackish fuscous dashes in the middle of the segments.....	eurytheme.
Interior not seen.	

Table of species, based on the chrysalis.

Surface vermiculations comparatively coarse; posterior lateral corners of the head above next base of antennae, sunken, glistening, slightly elevated; colors on either side of the lateral ridge of the frontal projection slightly contrasted.....	philodice.
Surface vermiculations comparatively delicate; posterior lateral angles of the head like the rest of the surface, scarcely elevated; colors on either side of the lateral ridge of frontal projection strongly contrasted.....	eurytheme.
Interior unknown.	

Table of species, based on the imago.

Males normally with a narrow black border to the fore wings above, in the middle not so broad as the width of an interspace; usually with no discal spot on same wings. *Females* with no black or gray border on hind wings above, or at most a few scales in the subcostal region.....**interior.**

Males normally with a broad black border to fore wings above, in the middle at least as broad as the width of an interspace; always with a discal spot on same wings. *Females* with a black or gray border on hind wings above, though ill-defined, extending beyond subcostal region.

Colors normally yellow.....**philodice.**
Colors normally orange.....**eurytheme.**

EURYMUS INTERIOR.—The pink edge.

[The pink edge (Scudder); bordered green butterfly (Maynard); Cape Breton butterfly (Maynard).]

- Colias interior* Scudd., Proc. Bost. soc. nat. hist., ix: 108-109, fig. (1862); — [Graef-Teppe], Bull. Brookl. ent. soc., 1: [90] (1879); — Edw., Syn. N. A. butt., [5] (1882); — Hagen, Proc. Bost. soc. nat. hist., xxii: 159-161, 166-167, 174-175 (1883); — Fern., Butt. Me., 34 (1884); — French, Butt. east. U. S., 135-136 (1886); — Elwes, Trans. ent. soc. Lond., 1884, 17-19 (1884).
- Eurymus philodice* var. *laurentina* Scudd., Proc. Bost. soc. nat. hist., xviii: 189-190 (1876).
- Colias laurentina* Edw., Butt. N. A., ii, Col. ii-iii, last page of text (1876); — H. Edw., Pac. coast Lep., 123 [24: 7] (1877); — Mayn., Butt. N. E., 44-45 (1886).
- Colias pelidne* Streck., Lep., 69 (1874); — Mayn., Butt. N. E., 43-44; pl. 8, figs. 56, 56a (1886).
- Colias pelidne* var. *interior* Streck., Lepid. 133 (1877); Cat. Amer. Macrolep., 81 (1878).
Figured also by Glover, Ill. N. A. Lep., pl. 32, fig. 3 (ined.).
(Not *Colias philodice* God., nor *C. pelidne* Holsd.)

Yellow butterflies flutter and float.
Jeweled humming-birds glitter and glow.
And scoring the ways of such idle things
Bees flit busily to and fro.

MRS. MOULTON.—*Morning glory.*

Imago (7: 7, 10; 15: 8). Head covered above with reddish pink hairs, with intermingled infuscated and blackish ones, which are especially conspicuous just outside the antennae, in the middle of the posterior half of the summit supplanted in the ♂ occasionally, in the ♀ always, by pale yellowish hairs; in the latter sex the external hairs of the front are also yellow; behind the eye clothed in both sexes with yellow scales, next the summit changing to pink. Palpi greenish yellow, scarcely tinged with orange in the ♂, in the ♀ sometimes pale at the base. The lower fringe a little brownish apically, the apical joint dark pink, yellowish toward the base, especially beneath, above sometimes with intermingled black scales; apical half of middle joint also dark pink above. Antennae reddish pink, beneath almost carmine; the upper surface flecked indistinctly and slightly with fuscous, some of the basal joints tipped faintly beneath with dusky; the club considerably infuscated above, especially on apical half, rather narrowly bright luteous in a naked space below, the last two or three joints wholly naked, dull yellowish luteous.

Prothorax covered with rather long, pale reddish pink hairs, the middle ones mostly pale, sometimes tinged with greenish at base. Thorax black, furnished above with long, pale, silky, iron green gray hairs, next the prothorax tinged a little with pink, beneath covered with yellow hairs, tinged with pink on the coxae; femora bright pink anteriorly, yellow above and posteriorly; tibiae and tarsi pink, flecked a little, especially posteriorly, with yellowish, beneath yellow; spines pale yellow; spurs pale green, the apical third reddish; claws pale luteous, palest at base.

Wings above bright greenish yellow, slightly less vivid in the female than in the

male; *fore wings* with the extreme base, especially next the inner border, heavily begrimed with blackish griseous scales; costal edge distinctly bright pink, and the costal border sometimes slightly flecked with griseous, generally most abundant next the extreme edge; the extremity of the cell is marked by a slight, obscure fuscous, round-ovate, narrow dash, inconspicuous and usually even obsolete in the ♂, in the female sometimes enclosing a very pale orange nucleus; the outer border is margined with blackish brown (♂), or blackish griseous (♀); the nervures which cross it are almost always delicately traced in yellow, close to but not reaching the outer border in the male, where the bordering is moderately broad, its interior edge pretty well defined, slenderly crenulate, pretty regularly curved on the lower three-fifths of the wing, where it is subparallel to the outer border, varying in width in different individuals, from a half to a whole interspace; it has a slight enlargement in the medio-submedian interspace, and at the inner margin sends a slender shoot for a short, sometimes a very short, distance baseward; above the subcosto-median interspace it curves considerably and regularly inwards, and terminates on the costal margin, above a point midway between the tip of the cell and the inner margin of the band; the whole border is sometimes very slightly flecked with yellowish scales. In the female the position of the upper part of the border is much the same, but its inner limit is ill-defined and powdery, the lighter scales showing a tendency to collect in small, longitudinally ovate dashes in the interspaces; in the middle of the wing the griseous scales run baseward along the nervules, and the brighter scales cluster in the interspaces, so that the inner limit is sometimes sharply serrate; in all but rare cases it fades out altogether in the medio-submedian interspace, and never extends along the inner margin. Fringe uniform bright pink, below the middle of the medio-submedian interspace yellowish. *Hind wings* with the extreme base, especially along the median nervure, but rarely more than a quarter the distance to its first divarication, rather heavily begrimed with blackish griseous scales; the rest of the wing also sometimes faintly and very sparsely flecked with griseous in the ♀, below the median nervure; on the upper half of the vein closing the cell a roundish, pale orange spot, almost never at all conspicuous, and sometimes almost completely obsolete, larger in the female than in the male, and sometimes very large; outer border of the ♂ margined as in the fore wing, having a well defined, pretty regular inner border, sometimes slightly stepped; at its broadest in the lower subcostal interspace, the band scarcely equals the narrowest part of the band of the fore wings; it tapers at either end, more rapidly above than below, and extends from beyond the middle of the costo-subcostal interspace to the upper extremity or middle of the lower median interspace. In the ♀ it is ill-defined, sometimes entirely absent, at others shows itself only by a narrow flecking of the subcostal nervules, at others with a broader flecking, expanding apically, so as to run together at the margin. The fringe is bright pink, more or less broadly and faintly interrupted in the upper third of the outer border with whitish.

Beneath *fore wings* greenish sulphur yellow, a little paler next the inner margin; the costal margin, as far as the upper limit of the cell, and in the female the apex of the wing, rather heavily flecked with griseous; the apex of the cell marked by a distinct, transverse, oval or linear, pale streak or spot, tinged with orange, edged throughout, generally rather narrowly, sometimes, especially in female, very broadly, usually more broadly below than above, with blackish fuscous, extending from the subcostal, almost and sometimes quite to the median nervules. Fringe dark pink at extreme base, pointed with pink or fuscous at the nervures and creases, beyond paler pink, below the submedian as above. *Hind wings* slightly less clear yellow than the fore wings, sparsely (♂) or considerably (♀) flecked with greenish griseous scales, which are less abundant in a broad, marginal band of one and one-half interspaces in width, sometimes widening in the middle of the wing; in the female they are occasionally so abundant as to give a decided greenish griseous tinge to the wing; the costal edge is pink, and at the extremity of the costal nervure there is sometimes a slight cluster of reddish brown or fuscous scales; the tip of the cell is marked by a small, circular silvery white spot, larger in the ♀ than in the ♂, in the outer part of which,

pink scales are mingled (and which sometimes nearly supersede the white) edged rather broadly, especially in the ♀, with dark brownish pink, and occasionally, especially in the ♂, sending out a brief spur on the outer, and less often on the inner side; generally the diameter of the whole spot does not exceed the width of the base of the lower subcostal interspace, and in one specimen seen it was wholly absent; usually, too, it is single, but it is occasionally accompanied, especially in the female, by a similar small spot, seldom more than a large dot of brownish pink, in the lower subcostal interspace, resting upon the larger spot; fringe as on the fore wings, but on the upper-third the apical half is whitish.

Abdomen above black, heavily flecked with yellowish green scales, beneath covered with pale yellowish hairs and scales. Hook of eighth segment of male (35:3) about two-thirds the length of the rest of the segment, bent in the middle. Hook of upper organ larger and stouter than in the other species. Claspers so deeply excised that the shortest is scarcely more than half as long as the longest part of the blade, expanding again considerably at the upper extremity, to a length very nearly equal to the lower portion, flat or convex, and with the upper angle curving inward more than in *philodice*.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	18.75	22.5	24.25	23.5	26.	28.25
antennae.....	7.5	8.2	8.5	8.	8.8	9.
hind tibiae and tarsi.....	5.6	7.	7.2	7.	7.2	8.
fore tibiae and tarsi.....	4.26	5.25	5.5	5.35	5.5	6.

Described from 7♂, 7♀.

Dimorphic forms. The above description is drawn up from the syngenic form, which may be termed *EURYMUS INTERIOR LAURENTINA* (7:10), as the syngenic female was first described under the varietal name *laurentina*. The antigenic females, for which the name *E. I. INTERIOR* (7:7) may be retained, since in the earliest description they were supposed to be the only type, appear on the whole to be commoner than the syngenic, are pallid above, with a faint, greenish tinge, in some stronger than in others; the interior of the spot at the apex of the cell of the fore wings is also pallid, sometimes very faintly tinged with orange, and the same spots on the hind wings are so pallid as to be very obscure, sometimes with the slightest possible tinge of clay yellow. Beneath, the hind wings do not differ from those of the syngenic females, but on the fore wing all of the wing normally covered by the hind wing in repose is as pallid as above, and this includes the centre of the discal spot.

Secondary sexual distinctions. The differences in coloration between the sexes have been described. The androconia (46:38) situated at the base of the costal margin of the hind wings above are well rounded, oval in shape, from less than two to nearly three times as long as broad, the apex rounded, with no angles except at the inconspicuous basal lobes, and delicately striate. They are slenderer and more rounded than in *E. philodice*.

Egg. Of the same general shape as in *philodice*, except in being slenderer, being three times longer than broad, with about twenty longitudinal ribs, which are .06 mm. apart in the middle of the egg, and between which run with tolerable regularity low cross lines of nearly equal width, which have an average distance apart of .035 mm. The surface is studded profusely with shallow circular punctuations about .0035 mm. in diameter. Height of egg, 1.5 mm.; greatest width, .45 mm.; width at summit, .12 mm.

Caterpillar. *First stage.* Head black, faintly shagreened, the hairs pellucid. Body dull faintly greenish fuscous, unicolorous; raised points black and profusely distributed, giving a still more grimy appearance to the body color; papillae faintly pallid, the base of the hairs fuscous, rest pellucid, wine-glass shaped, the bowl longer than broad, turned inward, with no distinct stem, and differing only in the slightest degree from the same parts in *E. eurytheme*; those of the first thoracic segment are all long, of equal length, at least four times as long as the others; shorter hairs club-shaped; spiracles blackish. In *E. eurytheme* a yellow, in the present species a brown tint prevails.

It is a little larger than *E. philodice*, the black points are a trifle larger than there, and Mr. Fletcher thinks the ground color more yellowish than in *E. philodice*, but of this I am not so confident; the wine-glass shaped appendages below the uppermost series have the cup longer than broad, while in *philodice* it is of equal length and breadth.

Geographical distribution (25: 6). This butterfly is a member of the Hudsonian fauna and apparently is most at home along the northern shores of Lake Superior, from whence it was first brought thirty years ago by Professor Agassiz. It has rarely been found south of the Dominion of Canada, but extends along a tolerably wide belt of country from the Rocky Mountains to the Atlantic. If Hagen is right in assigning to this species several forms which have been described under other names, then its range is much wider than here indicated. But as it is not in my power to make the necessary comparisons at the present time, I prefer to follow here the guide of Edwards, who has proved to be nearer correct in his judgment of affinities among the species of *Eurymus* than has Hagen, in several instances where breeding experiments have settled matters previously in doubt. This butterfly, then, has been found at least as far as the Rocky Mountains, and in the extreme west has been taken by Geddes at Stephen, the highest point of the Rocky Mountains traversed by the Canadian and Pacific Railroad, by Tyrrell at Miry Creek, lat. $54^{\circ} 4'$, long. $112^{\circ} 10'$, at the mouth of the Saskatchewan (Scudder), and at Moose* on James's Bay (Edwards); along the northern shore of Lake Superior it swarms to a point at least as far south as Sudbury, north of Georgian Bay, where it is abundant (Fletcher, Scudder); east of this it has never been taken in any great numbers, but is recorded along the north coast of Labrador from Sawbill River to Natashquan (Couper), the Mingan Islands, Anticosti (Couper), Godbout River "rare" (Corneau), Cape Breton (Thaxter) and Newfoundland (Edwards), the latter point being brought to my notice after the preparation of the map. It is reported from Buckingham near Ottawa (Whyte); Mr. Caulfield has also found it on Montreal Mountain, it has been taken at Quebec, and Mr. Mann procured one specimen at Owl's Head, Lake Memphremagog, just north of our border.

In New England it has only been taken on two occasions, once by Professor Hamlin at Waterville, Me., and once by myself at Franconia Notch, N. H.; but it seems highly probable that in the northern part of New England it will be found not very uncommonly if sought for at the proper time. It has probably been heretofore confounded with the common *philodice*.

Haunts. Mr. Couper, speaking of this butterfly as it occurs on the Labrador coast, says: "It is not frequently seen near the sea; but generally

* Perhaps this was one of the forms from Moose identified by Wier under other names.

met with in the woodland and mountain regions in the interior." So, too, at Nepigon it was not found next the shore of the bay in fields where *E. eurytheme* occurred, but in places better protected from the wind, along the railway cuttings and in the grassy channels by their side; and at just such places along the railway, did the species abound further east.

Food plant. The food of this caterpillar remains unknown. Mr. Fletcher was the first to obtain the egg, and, curious to relate, it was by manipulating the abdomen of a female that had refused to lay, until an egg passed through the ovipositor. He has since tried this plan upon various butterflies with equal success and fairly opened a new method with refractory butterflies, which may yet prove of the highest importance. This caterpillar refused in turn *Trifolium repens*, *hybridum* and *pratense*. Last year he obtained many eggs, and the history of the larvae that resulted, which were divided in equal parts between Mr. Edwards, Mr. Fletcher and myself, I will give in his own language:—

"We all tried them with every kind of leguminous plant we could obtain, but all failed to get the larvae to feed. Some eggs were left upon the clover where they were laid, until they hatched; but they like the others refused to eat, and after wandering about for two days, dried up. Some were placed in a refrigerator at once upon hatching [hoping they wished to hibernate], but they fared no better than the rest. It seems to me worth mentioning, however, that in one jar where young larvae were confined with leaves of several plants, they all gradually congregated upon leaves of a *Desmodium* and three specimens spun a small crescent of silk somewhat similar to the silken path spun by young *Colias eurytheme* and *C. philodice*, to the end of which they go to feed and upon which they retire to rest. These three larvae which spun these little silken crescents also passed a tiny pellet of pink excrement. They would not feed, however. The only *Desmodium* available was *D. canadense*, a hairy species, and it is possible they could not get at the leaf on account of the hairs. At any rate the indications are that *Desmodium* is a possible food plant. A confirmatory fact is that one of Mr. Seudder's larvae did exactly the same as my three and spun its little crescent upon a leaf of *Desmodium*. *Lathyrus ochroleucus*, *Astragalus*, *Vicia*, *Pisum*, *Trifolium* all were refused. Mr. Seudder tells me that in Europe a species of this genus feeds upon *Vaccinium* and a noticeable feature of all the localities where I have taken interior is that bushes of this genus are abundant."

The European species referred to was *E. palaeno*, which is a closely related form and therefore more likely to feed on an allied plant. In my own case, I placed the eggs in closed tumblers, each furnished with fresh leaves of two different kinds of leguminous plants, in all six or more genera; among them *Lathyrus*, *Desmodium*, *Lupinus*, *Lespedeza* and *Gleditschia*, besides *Gaylussacia*. *Desmodium* was placed in two of them, and in one

of these not only was the leaf not deserted as quickly as possible, as was the case with all others, but the young caterpillar certainly ate a very little parenchyma of the upper surface near the middle; it then spun this silken carpet and never left it again, dying upon the spot.

Life history. The species is single brooded, and does not appear on the wing until July or the very end of June. At Nepigon north of Lake Superior, not one was seen last year before July 10; and although great numbers were seen on July 4 along the railway between Markstay and Ramsey, apparently all males, none were seen the following day between Schreiber and Nepigon (the intervening country being passed in the night). At Sudbury on July 12-13 not many were found but among them some females. The specimen I took in the White Mountains was taken June 28 and was a worn male. Mann took a specimen at Owl's Head, Lake Memphramagog, on July 11, Professor Hamlin a fresh female at Waterville, Me., July 14, Corneau reports it at Godbout, July 15, Tyrrell at Miry Creek, July 19, Couper at Mingani, July 22 and Caulfield at Montreal at the end of July. Eggs are laid in the latter half of July; Mr. Fletcher obtained them July 16-24, and they hatch in seven days. This gives ample time for the caterpillars to attain maturity and pass into pupa for the winter, but what the creatures actually do and how winter is passed is unknown. There is, however, certainly but one brood anywhere. The males are very much more numerous than the females.

Flight and habits. Like its congeners this butterfly is fond of moist earth and assembles in great numbers at suitable places. Its flight closely resembles that of *E. philodice*, having all its peculiarities except that it appears to be somewhat less hurried and vigorous. Geddes, who appears to have had much out door experience in collecting different *Eurymi*, puts this down as easy to capture, adding "apparently a lazy insect."

Desiderata. The later larval stages and chrysalis of this butterfly being unknown, as well as the food plant of the caterpillar, the last must be our first search. If *Vaccinium* should prove as unpalatable as leguminous plants have done, observation of a butterfly ready to lay will be the only resource left, though it would be worth while to try *Sanicula*, which Mr. Fletcher tells me is found at Nepigon and is not far removed from *Hydrocotyle* on which *E. palaeno* is also said to feed. Some specimens should then be bred on their natural territory under conditions so nearly natural as possible to discover how the winter is passed. This done, the most will have been learned, but the study of the relations of this butterfly to those which have been claimed as identical with it will still demand a similar solution. Why do the males predominate so largely in this species? What are its enemies? And what its habits and behavior?

LIST OF ILLUSTRATIONS.—EURYMUS INTERIOR.

- General.*
Pl. 25, fig. 6. Distribution in North America.
Imago.
Pl. 7, fig. 7. E. l. interior ♀. Both surfaces. Pl. 7, fig. 9. E. l. laurentina ♀. Both surfaces 15; 8. Male, upper surface. 35; 3. Male abdominal appendages. 46; 38. Androconium.

EURYMUS PHILODICE.—The clouded sulphur.

[The clouded sulphur (Gosse); Philodice butterfly (Harri); clouded sulphur butterfly (Emmons); loyal Collas (Emmons); yellow butterfly (Ross, Riley); bordered yellow butterfly (Maynard).]

- Collas philodice* God., Encycl. méth., ix: 87, 100-101 (1819);—Boisd.-LeC., Lép. Amer. sept., 64-65, pl. 21, figs. 1-3 (1833);—Boisd., Spec. gén. Lép., 1: 647-648 (1836);—Gosse, Can. nat., 183, 223, 262, 323 (1840);—Luc., Pap. exot., 78-79, pl. 39, next to lower fig. (1845);—Emm., Agric. N. Y., v: 204, pl. 35, figs. 1, 2, 4, 9 (1854);—Menétr., Catal. coll. entom. Acad., 1: 15 (1855);—[D'Urb.], Can. nat. geol., ii: 317-318, pl. 4, figs. 2 a-c (1857);—Harr., Ins. inj. veg., 3d ed., 272-273, figs. 100-102 (1862);—Morr., Syn. Lep. N. A., 29 (1862);—Scudd., Proc. Bost. soc. nat. hist., ix: 103-104 (1862);—Linn., Proc. Entom. soc. Philad., iii: 54-55 (1864);—Saund., Can. ent., i: 54-55 (1869); Rep. Ent. soc. Ont., 1874, 26-27, figs. 25-26 (1875);—Beth., Can. ent., v: 221-223, figs. 21-22 (1878);—Edw., Butt. N. A., ii, Col. 2-3 (1876);—H. Edw., Pac. coast Lep., 132 [xxiv: 6] (1877);—Elwes, Trans. Ent. soc. Lond., 1880, 137 (1880); 1884, 6, 16-17 (1884);—Burg., Proc. Bost. soc. nat. hist., xxi: 154, fig. 1 (1881);—Hag., Proc. Bost. soc. nat. hist., xxii: 167-168, 174 (1883);—Fern., Butt. Me., 32-34, figs. 8-11 (1884);—French, Butt. east U. S., 133-135 (1886);—Mayn., Butt. N. E., 44, pl. 7, figs. 57, 57a-c (1886).
Eurymus philodice Swains., Zool. Ill., (2) ii, pl. 60 (1831-32);—Scudd., Butt., 134-135 (1833), 303, 309, figs. 5, 11, 42, 52, 56, 102-104 (1861).
Collas (Eurena) philodice Steph., Cat. Brit. Lep., 252 (1850).
Papilio hyale var. Abb., Draw. ins. Ga. Brit. Mus., vi: 14, fig. 8; 13, figs. 64, 65 (ca. 1860).
Colias dorippe God., Encycl. méth., ix: 87, 101 (1819).
Zerene anthyale Hübn., Zutr. exot. schmett., ii: 21, figs. 307-308 (1823).
Colias europae Steph., Brit. ent. Haust., i: 10-11, pl. 1*, figs. 1-3.
Eurymus europae Swains., Zool. Ill., (2) ii, pl. 70 (1831-32).
Colias phicomone Fitch, Trans. N. Y. st. agric. soc., xiii: 378 (1854).
Colias nastes Fitch, Ibid.
Colias santes Fitch, Ibid.

Figured also by Glover, Ill. N. A. Lep., Pl. 1, fig. 77; pl. 32, figs. 1, 2; pl. G, fig. 11; pl. I, fig. 5, ined.

[Not *Papilio hyale* Linn.; nor *Papilio phicomone* Esp.; nor *Collas nastes* Boisd.

From dewy lanes at morning
The grapes' sweet odors rise,
At noon the roads all flutter
With yellow butterflies.
By all these lovely tokens
September days are here.

HELEN HUNT JACKSON.—September.

He is the friend of our summer gladness.

WORDSWORTH.—Redbreast and Butterfly.

Imago (7: 6, 8, 9; 13: 6, 8). Head covered above with dark, dull pinkish brown hairs, darkest on the outer parts of the back of the summit, changing to greenish yellow on the sides of the front and in the middle of the hinder part of the summit, behind the eyes covered with yellow scales becoming somewhat tinged above with pinkish; palpi lemon yellow, the inferior fringe slightly infuscated especially toward the apical joint, occasionally tinged with pale pink, the upper part of the sides flecked faintly with dusky scales toward the apex of the middle joint and with whitish next the base of the free portion of the same; above more or less tinged with dusky pink. Antennae rather dark pink, changing beneath to rosaceous; on the inner inferior surface, excepting toward the base, an oval, naked patch of luteous color; the c. is a little

darker above than the stalk and is almost wholly naked beneath; its apical two joints are wholly naked and dull, often dusky luteous, in life more yellowish. Tongue pale on its basal fourth, the remainder brownish fuscous, a little paler at tip.

Prothorax covered with pink or salmon colored scales and hairs, becoming generally very dark brown at the base. Thorax black covered above with rather dark greenish yellow hairs, the inner edges of the patagia and to a greater or less extent the front of the thorax between them with pinkish hairs; beneath with uniform greenish yellow hairs. Legs beneath and inside yellow, the rest pink, very deep on the femora but becoming paler all the way toward the claws, the coxae often slightly tinged with pink, and the tips of the femora more or less annulate with the same; spines dingy pallid, spurs the same, their apical third much infuscated; claws very pale pinkish, almost pellucid at base.

Wings above rather pale greenish yellow, of the same tint in both sexes; outer border of fore wings curved slightly throughout. *Fore wings* with the tip of the cell marked by a transversely oval black spot, which touches the lowest subcostal nervule above and just falls of reaching the median nervule below; costal edge dark pink; costal border more or less begrimed with blackish scales as far as the costal nervule in the ♂, but in the ♀ as far as one-third the way across the cell; the extreme base of the wing similarly begrimed below and in the ♀ sometimes extending half as far as the first divarication of the median nervule, generally most extended along the inner margin; outer border bordered with blackish brown, generally faintly and slightly flecked with yellow scales, some of the veins in the ♀, especially those on the upper half of the wing and on the interior half of the margin, marked delicately with yellow. In the ♂ the marginal band has a distinct interior border, generally slightly and often irregularly crenulate, but least so in the middle of the wing; it varies in width in the middle of the wing from one-half to one and one-half interspaces' breadth, but is usually about an interspace; the interior border runs from the costal margin at about the tip of the first superior subcostal nervule in a regular and considerable arc to the subcosto-median interspace; below this runs parallel to the outer border as far as the submedian nervule and then turns inward to a greater or less extent toward the base, sometimes extending even to the middle of the inner border; in the ♀ it is much broader, sometimes reaching the width of two interspaces, its interior border ill-defined and irregular, but it has a general direction as if made up of two lines bent at the upper median nervule, the lower parallel to the outer border and scarcely turned toward the base beneath, the upper at an angle of about 135° with it; it encloses a transverse series of ill-defined, roundish or slightly longitudinal, yellowish spots, parallel to the outer border on the lower two-thirds of the wing and nearer the interior than the exterior margin, in rare cases almost wholly obliterated, especially below, and in some instances breaking up the interior margin altogether; no or only a very faint spot is present in the upper median interspace; on the upper part of the wing it curves inwards subparallel to the interior border of the band and generally more distinct than elsewhere; infrequently all the spots are inconspicuous. Fringe pink, yellowish at the lower outer angle and flecked more or less with yellow the next base throughout. *Hind wings* having the central spots of the under surface appearing above with a pale orange, occasionally yellowish hue; the outer border is margined with black; in the ♂ it forms a connected band like that of the fore wings, but narrower, broadest in the lower subcostal interspace, but there scarcely ever equaling the width of more than an interspace and often not so much as half an interspace; it tapers toward either extremity, more rapidly above than below, extending from at or a little beyond the tip of the costal nervule to the middle of the medio-submedian interspace, or sometimes only to the lower median nervule; the inner border is sharply defined, sometimes irregular but usually only to a slight degree and scarcely crenulate; the nervules are often delicately traced with yellow on the interior half of the band. In the ♀ the band is seldom, though occasionally, formed with the same continuity as in the ♂, but with a more or less blurred interior limit, and the nervules, instead of being traced partly across the band in yellow, are marked and edged with griseous, forming usually the darkest part of the band and extending beyond its limits nearly as far again toward the base; usually the band is greatly broken and conspicuous only by these dark edged nervules, which with the scales which cluster around them often form a series of triangular spots

seated on the outer border, connected only by their bases; there are seldom any marks of the band below the middle median nervule and it is occasionally restricted altogether to the subcostal area; fringe pale pink and yellowish, the former prevailing on the lower, the latter on the upper half.

Beneath varying from rather pale to rather deep sulphur yellow, generally brighter in the ♂ than in the ♀; *fore wings* usually paler on the lower half of the cell and the base of the median interspaces, always paler next the inner margin; the costal margin broadly bordered with a distant flecking of dusky scales and the costal edge of rather a dark pink; outer limits of the cell marked by a transversely oval or roundish black spot, similar to that on the upper surface but usually proportionally broader in the ♀ than in the ♂ and having a transverse white dash in its centre; across the middle of the outer two-fifths of the wing is a transverse series of generally not very distinct occasionally often obsolete, dusky spots; below the subcostal nervure they are in a straight series, scarcely farther from the outer margin below than above, but there is seldom more than a dot in the subcosto-median interspace; above the subcostal nervure the series curves strongly inward, the last one being scarcely within the middle of the outer half of the costal border; between these spots and the middle of the wing are often a few sparsely scattered dusky scales; fringe pink, changing to yellow below the lowest median nervule and often infringing on the edge of the outer border so as to make the fringe of apparently double width. *Hind wings* not infrequently uniformly and considerably flecked with dusky scales, giving the wing a rather faint, griseous appearance; costal border and very frequently all the other borders edged narrowly with pink; at the extreme base of the wing, in the middle, extending a very short distance into the cell, a short, dark pink, longitudinal dash; at the extremity of the cell a round or roundish silvery spot edged with a dull ferruginous brown annulus flecked slightly with dusky; with the annulus it reaches from the lowest subcostal nervule more than half way to the upper median nervule and is surrounded by a broader clouded annulus of a paler, usually somewhat ochreous tint which deepens at its external limits to a slender circle of a color as deep as the inner annulus; resting upon this compound spot is a similar one, when largest less than half the diameter of this, seated near the base of the lower subcostal interspace; it is, however, frequently much smaller or to a considerable extent obsolete; the silver is the first to disappear and occasionally the whole spot is altogether wanting; in the middle of the outer two-fifths of the wing is a transverse series, nearly parallel to the outer border, of quite small, rather indistinct spots of ferruginous pink, sometimes reduced to mere dots in the subcostal, median and medio-submedian interspaces; and in direct continuation of the series a transverse dusky pink or ferruginous bar crossing at least the upper half and generally the whole of the costo-subcostal interspace and reaching to the costal margin; in specimens where the dark markings are darkest, the costal margin is more or less conspicuously marked with dusky fleckings which then connect with the base of this bar; fringe pink, its thinner outer half pale or whitish.

Abdomen above blackish very heavily flecked with greenish yellow scales; below pale yellow, palest ventrally. In the male the hook of eighth segment (35: 4.5) is scarcely more than one-third the length of the rest of the segment, arched and almost equally stout throughout excepting at the very extremity which is suddenly narrowed and dependent. Hook of upper organ slenderer and rather smaller than in *E. interior*. Claspers half as broad at the upper extremity as near the lower, but not broadened above, the upper extremity broadly and deeply channelled transversely in the middle, the upper angle less incurved than in *E. interior*.

Measurements in millimetres. Length of tongue, 10 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	20.	23.5	28.	18.5	25.	28.25
antennae.....	7.5	8.5	10.	6.85	8.5	9.5
hind tibiae and tarsi.....	6.	7.5	8.15	5.6	7.75	8.75
fore tibiae and tarsi.....	4.75	5.5	6.	4.45	5.2	6.

Described from numerous specimens.

Mr. Edwards has a male whose entire expanse is but 28 mm., and a female whose expanse is 30 mm.; I have a female whose fore wing measures but 16 mm.; and Mr. Saunders sent me a male from Canada, the length of whose fore wing was only 8 mm.! The average size of individuals from the Mississippi valley is much greater than I have seen from other places, the ♂ sometimes having a length of wing of 30 mm., and the ♀ of 33 mm., but such specimens do not occur in New England. They are also never begrimed with griseous scales to the extent one finds the case in New England.

Malformations. In a specimen before me one of the antennae is slightly malformed, the seventh and eighth joints from the tip (that is, just at the base of the club) being divided by a strongly oblique suture, which has altered their shape, the two together being not regularly cylindrical and scarcely longer than a single joint should be; each joint is wedge-shaped, the proximal thrust a little out of linear plane making a distortion visible to the naked eye; it is apparently the first step toward a bifurcation of the antennae, since it would require but little more distortion to permit a second club to find support at the tip of the proximal joint.

Aberations. Mr. F. H. Sprague has shown me a male, taken at Wollaston, July 10, in which the discal spot of fore wing is double, both on the upper and under surface, in which it distinctly imitates the homologous spot of the hind wing, the secondary spot being above and smaller than the main spot and confluent with it; it shows above no trace of pale scales within it but beneath has a transverse, partially confluent, pale bar consisting of mingled yellow, silvery, and ferruginous scales.

A male taken November 10 at Bangor, Maine, by Mr. Carl Braun, is remarkable for having all the wings especially the disc of the upper surface, shot with orange; the orange, though deep in color, is not of a solid character but more or less intermingled with normal yellow scales, giving a somewhat pink appearance. The insect indeed looks as if it had been kept too long in the cyanide bottle; but Mr. Braun assures me that it had the same appearance while on the wing, causing him to capture it; the lateness of the season of capture will be noted in this connection. The insect looks tolerably fresh and possibly emerged from the chrysalis just before a sharp frost.

Strecker states that he has a male specimen taken near Montreal in which the upper surface is "dull dark green" with the usual border, and beneath dull green.

Females are sometimes taken in which the spots in the marginal band of the fore wings are either absent or so far removed toward its interior border as to leave the same ragged. Sometimes also, both in this species and the next, the outer margin, in either sex, may be dusted with yellow scales, sometimes confined to the front wing sometimes common to both. The range of variation is well indicated by Edwards in the second volume of his superb Butterflies of North America.

EURYMUS PHIL. STAUDICE. This name may be given to the sport rarely seen which is figured by Edwards (Butt. N. Am., II, pl. Collas 3, figs. 8-9) and by Glover in his unpublished work (Ill. N. A. Lep., pl. I, fig. 5). Three specimens were seen at Palmyra, N. Y., by Mr. Worthington of Chicago but only one captured, and this is the specimen that has been figured. It is a male, wholly smoky black above, but with a pink fringe, and with the margin distinguished from the rest by a slight paleness, the very opposite to what one would expect. The under side of the fore wings is wholly smoky brown excepting the yellow tip, while the hind wing is normal. Another taken by Mr. Pearson near Montreal was described by him as "deep brownish black" above, "somewhat green tinted if seen obliquely." On the under side the primaries are dark brown and secondaries almost olive green." Mr. J. G. Jack also captured another specimen many years ago, in the same locality.

A female in which the melanism has gone not nearly so far was taken at Faulkner, Mass., July 29, 1883, by C. C. Beale and figured by Maynard (Butt. N. E., pl. 7, fig. 57c). In this the band of the hind wing is far broader than usual, but otherwise this wing is normal; while on the fore wing the basal half of the inner margin and some parts of the disc above it retain the normal yellow. Mr. F. H. Sprague tells me that Mr. Beale took in August another partially melanized female, which in this instance was the more marked from its being one of the form *E. phil. pallidice*!

E. p. MISCEIDICE. Mr. F. G. Sanborn has shown me a very interesting suffused female of this species taken by Mr. John Osgood in Lynn, Mass., in August, 1893. Fore wings *above* wholly and uniformly blackish griseous, excepting a clear yellow space on the middle half of the inner border, reaching as far as to the middle of the medio-submedian interspace, and excepting also that the base of the median and medio-submedian interspaces as far as half way from the base of the lower median nervule to the outer border is heavily, and the base of the wing within this lightly, flecked with yellow; there are also faint indication of the yellow spots of the marginal border, but excepting next the inner margin the border as well as the spot at the apex of the cell is wholly merged in the general tint. On the hind wings the outer border is very faintly indicated, the whole wing but especially the lower half considerably begrimed with griseous flecking and the central spot of the under surface but faintly indicated by any distinct spot above, while the whole centre of the wing has a slight orange tint. *Beneath* the fore wings have the usual spot at the tip of the cell, but from the points where the position of the transverse series of spots belong commence broad, blurred, longitudinal streaks of blackish fuscous, following all the interspaces in the direction of the base of the wings, excepting the base of the lower median, nearly filling also not only the subcosto-median interspace, but also most of the cell; all the other parts of the wing are also lightly flecked with dusky scales. On the hind wings the changes are somewhat similar; the central and basal spots are normal and there is a faint indication of the costal bar; the outer fifth of the wing is also as usual, while the whole wing within that, at least below the middle subcostal nervule, is suffused with a mingled griseous and pinkish flecking, the latter most prominent along the middle of the interspaces. Expanse 55 mm.

A first approach toward this suffusion is shown in a specimen bred by Mr. Edwards in West Virginia and figured in the Butterflies of North America, II, pl. Collas 3, fig. 7.

Dimorphic forms. The description of the species given above is drawn up from the normal form, *E. p. philodice*. The pallid form of the female is well known, has been excellently figured by Edwards (Butt. N. Amer., II, pl. Collas 2, fig. 6; pl. Collas 3, figs. 5, 6) and by Glover (Ill. N. Amer. Lep., pl. G, fig. 11, ined.) and may be described under the name

E. p. PALLIDICE. On the upper surface the yellow is wholly replaced by a sordid white scarcely tinged with green and upon which the dusky fleckings are more conspicuous and the central spot of hind wings is of a very pale orange. Beneath they are also pallid, especially on the fore wings, but not to so great an extent as above and on the apex of the fore wings and to a less extent on the costal margin of the hind wings they are considerably suffused with pale sulphur yellow; excepting the costal bar, all the markings of the outer half of the wings are obliterated in all but one of the specimens before me, but in that they are more than usually distinct. I believe this was first noted by Gosse in his Canadian naturalist (p. 184) and next by D'Urban in his unsigned articles in the Canadian naturalist (II: 318). In the north this rarely, almost never, occurs in the first brood of the season, and is found much more abundantly in the latest than in the middle brood, the numbers increasing as the season advances. In the south, however, if we may follow Edwards, it occurs not infrequently in the spring brood, but the only actual record he gives is of one taken May 8th, and as he reckons specimens taken by Lintner in N. Y. on June 20 as belonging to the first brood, when they unquestionably belong to the second, it is not impossible that the same rule holds in the south as in north (Can. ent., xiv: 50-51).

Secondary sexual distinctions. Besides the differences already detailed in the markings of the wings, there occur androconia (46: 37) collected in a patch at the upper base of the hind wings above, but not forming a visible "glandular" spot. They are colorless or nearly so, very finely striate, more than half as long again as broad, with broadly convex sides, strongly rounded angles, truncate apex and well marked basal lobes. They vary, however, considerably in form and are sometimes asymmetrical, but are in general stouter and more quadrangular than in *E. interior*.

Egg (65: 25). About eighteen longitudinal ribs, slightly raised but very distinct,

and equally prominent throughout; in the middle of the egg, they are, at most, .065 mm. apart; they reach but do not pass the delicately thickened rim of the summit; cross lines, .0127 mm. apart; surface granulated or crowded with low warts. Micropyle rosette (68:14), .076 mm. in diameter; the oval cells .0115 mm. long and .0084 mm. broad; the other cells roundish but angular, averaging .015 mm. in diameter; bounded by scarcely raised, coarse lines, rendering the whole very obscure. Color when first laid whitish, slightly tinged with pale greenish yellow; in forty-two hours they become pale salmon coloured; when fifty-six hours old they are bright reddish orange, yellowish in the slenderer parts, a color which they retain until shortly before hatching, when they turn to a plumbeous hue. Height, 1.24 mm.; greatest breadth, .44 mm.; breadth at base and summit, .1 mm.

Caterpillar. *First stage* (72:3). Head (79:46) shining piceous; papillae and hairs pellucid. Body dark yellowish brown with a faint, dusky, delicate, dorsal line, the segments tinged, especially on the anterior part of the body, with reddish, the raised points fuscous and very regularly distributed. Papillae fuscous; hairs pellucid, wine glass shaped, expanding greatly, being as broad at summit as the length and but little longer than the tubercle upon which it is seated, the lower ones changing to a club shape, being rounded and less expanded at the tip. Spiracles fuscous. Legs of the color of the body, tipped with black. Length of body, 1.75 mm.; of papillae of body including wart, .03 mm.; of hairs of first segment, .09 mm.; of papillae of head including wart, .04 mm.; breadth of body, .3 mm.; of head, .32 mm.

Second stage. Head uniform grass green with a yellowish tinge with scattered blackish fuscous dots, each bearing a short, pale hair; ocelli black, tipped with greenish. Mandibles reddish black. Body nearly uniform grass green with a narrow, faint dusky, dorsal stripe, a similar lateral stripe and a pale, stigmatal band; first thoracic segment with scattered, blackish fuscous dots, each giving rise to a short, pale hair; each of the five divisions of the segments supports a transverse row of eight minute, pale, fuscous tipped warts each giving rise to a short, pale hair. Length, 5.5 mm.; breadth, 1 mm.

Third stage (79:47). The colors remain unaltered. Specimens in the second and third day of this stage measured 8.5 mm. long and 1.5 mm. broad.

Fourth stage. Head grass green, sprinkled with pale dots from which short, blackish and whitish hairs arise; ocelli black, tipped with green; mouth parts green, the mandibles tipped with reddish fuscous. Body uniform grass green above and below; a faint, narrow, darker green, dorsal line, which is simply the indication of the dorsal vessel; a stigmatal, pale roseate band, a little broader than the length of the spiracles, scarcely reaching their lower extremity and extending some distance above, passes along the whole body excepting the tip of the last segment; whole upper surface profusely sprinkled with pale wartlets, arranged pretty regularly in transverse rows but irregularly in longitudinal ones, each emitting a short blackish or whitish hair; on the under surface less regularly disposed. Spiracles green with whitish lips. Legs green, tipped faintly and slightly with fuscous. Prolegs green. Length, 14.75 mm.; breadth, 2.5 mm.

Last stage (76:10; 79:48). Does not differ from the preceding stage, but shows some variation in the stigmatal stripe, which sometimes may be found in part at least in the previous stage. This band is sometimes whitish or only very slightly tinged with rosaceous and is occasionally interrupted with rosaceous in the middle of each segment, or it may have a delicate, uninterrupted, red line passing through the lower part of it, that is, through the centre of the spiracles; sometimes also, and especially where the stigmatal band is interrupted with rosaceous, there are, immediately below the rosaceous spots, that is, midway between the spiracles and the posterior border of each segment and usually occupying about one-third of that space, bordering the lower margin of the stigmatal band and usually about half as broad as it, patches of black, usually oblong ovate in shape, but sometimes crescentic. I have also seen specimens in which there were faint indications of an obsolete, lateral line in the presence of a few pink and white dots linearly arranged. Length, 28 mm.; breadth, 4 mm.

Mr. Edwards at one time thought these variations possibly indicative of specific differences (Can. ent., II: 179), and asserted that they produced equivalent variations in the imago, explaining in his latest publication that those with distinct black spots beneath the stigmatal stripe produced the deepest colored butterflies. But Mr. Riley informs me that in 1876 he obtained caterpillars with distinct spots beneath the stigmatal stripe and others without them from eggs laid by the same mother. So, too, caterpillars of *E. eurytheme* with and others without the pale supralateral line were obtained by Mr. Fletcher and myself from eggs laid by the same parent.

Chrysalis (84: 54, 55; 87: 4). Grass green throughout, vermiculate with yellowish white over the upper surface of the thorax and all of the abdomen so as to give a pale pea-green effect; the frontal prominence, a dorsal line over the whole body and a narrow, faint, suprastigmatal band free of these markings; on the wings the yellow tinge is more distinct and a narrow, yellowish, stigmatal band passes from tip to tip, interrupted at the prothorax; front of head and linear appendages grass green; nervures of the wings tipped minutely with fuscous and a fuscous dot at apex of cell; there is a lateroventral row of round fuscous spots on the fourth to sixth abdominal segments; and on the posterior part of the same segments, midway between this row and stigmatal line, a row of black dots, one to a segment. Length, 19 mm.; breadth, 5 mm.; height, 6 mm.

Geographical distribution (25: 7). This is a characteristic butterfly of the Alleghanian fauna, covering the country from the Atlantic coast to the Rocky Mountains, but also spreading north and south far into the neighboring faunas. In the north it is usually common, if not abundant, in all the lower half of the Canadian fauna. The northernmost localities from which it has been reported are Nova Scotia "very common" (Doubleday, Jones), Cape Breton (Graham Bell), Cacouna, Tadoussa, "common" (Saunders), Godbout, on the north shore of the St. Lawrence, "rare" (Corneau), Anticosti (Couper), Quebec, "very abundant" (Bowles), Ottawa (Billings), Collingwood, Bruce Mines and St. Joseph's Island, "plentiful," and Sault St. Marie, "excessively abundant" (Bethune), Duluth, "common" (Osten Sacken), and the Lake of the Woods (Dawson). Mr. Lyman reports that he has seen a specimen from as far north as Fort Carleton on the Saskatchewan. It is far more abundant in the east than on the western prairies, but it occurs through the valley of the upper Mississippi and is reported from such western localities as the Big Horn Mountains (Edwards), Dakota and Montana (Morrison, Allen), Fort Bridger, Wy. (Osten Sacken), and Colorado (Mead, Reakirt*), and from various localities in Iowa where it is nowhere very abundant. The specimens from Osage Co., Mo., in the Museum of Comparative Zoology came from near the southern boundary of the species, which toward the east is limited by about the northern boundary of the Gulf states. Dr. Bean, according to Mr. Uhler, has found it at a height of about 3000 feet above the base of Big Butte, one of the Iron or Smoky Mountains of Tennessee. It has been taken in abundance on Elk River, W. Va. (Edwards), and has been found in North Carolina (Hentz), Georgia, "rare" (Abbot)

*The specimens from Colorado are now regarded by Edwards as distinct.

and Mr. Morrison took a male certainly of this species in western Florida. In the collection of Mr. Strecker there is a specimen which is reported to have been brought from Rio!

The albinic female doubtless occurs throughout the entire region of the butterfly as it is common enough in the east and is reported from Georgia (Abbot) to Ottawa (Bowles), and was brought from Missouri (Stolley).

In New England, this butterfly is everywhere the commonest species to be found, excepting in certain years, when it seems to be affected by some unfortunate circumstances. It is found alike in the White Mountain region, where it ascends to the summit of the barren peaks, and on the shores of Long Island Sound, but it is generally more abundant in the southern than in the northern districts.

Mr. Edwards has expressed the opinion that the butterfly is spreading its territory westward. He says:

In the Mississippi valley the orange species predominate, but year by year philodice encroaches on their territory. Professor Snow states that it is becoming well known about Lawrence, Kansas, though as yet by no means equalling *eurytheme* in numbers. Mr. Dodge writes to same effect from eastern Nebraska. . . . The rapid advance of the species is probably owing to the fact that the food plant of its larva is the common red clover, which everywhere keeps step with the pioneer. The *Collades* are not at all forest species, and it is reasonable to suppose that, on the first settlement of the country, the range of philodice was restricted to the savannahs along the seaboard, or to open spots where the native species of *Trifolium* or of *Lupinus* grew; but that with the introduction of a more palatable or less precarious food-plant, it has increased and dispersed till it now occupies half the continent. (Butt. N. Amer., II.)

I do not see that we have yet any facts to support this notion. Undoubtedly it will flourish further westward the more land is brought under cultivation. Our knowledge of a wider western distribution is due simply to better information. It does not appear to be more common in Georgia than in Abbot's time. It was a very common species in central Missouri, when Stolley collected there, at least as long ago as 1857, and its simple occurrence west of the Great Plains is proof enough that it is not extending its territory, but only possessing it more fully.

The species is reported to have been formerly taken in England, and was described and figured by Stephens and Swainson as a peculiar form, but which is now universally recognized to be our species. The manner of its introduction is now past discovery. The wonder is that it did not survive. This is what Stephens says of it in 1828, in his *British Entomology* (Haust., i: 10-11):—

Very few British cabinets contain this interesting species, which, till last summer, does not appear to have been captured in England for upwards of forty years. I have hitherto seen but five specimens, four of which were in the rich collection of the late Mr. Francillon, and one in that of the late Mr. Marsham; of these I have been fortunate enough to obtain three, two males and a female, from which the accompanying figures have been taken. In *Lepidoptera Britannica* reference is also made to the collection of Mr. Swainson as possessing this species. The past season afforded no less than

eight examples—thus illustrating the irregular appearance of the *Coliades*—four of which were captured between Brighton and Lewes in Sussex; and a similar number in the vicinity of York, as I am informed by Mr. Cooper—these last were found in September—the others in company with *C. hyale* and *edusa*.

Since writing the above, I find, by the Butterfly-Collectors Vade-Mecum, that this species is said to occur, though rarely, in the meadows and roadsides near Ipswich in Suffolk, in the middle of August.

Haunts and abundance. This butterfly is found everywhere in open fields, meadows and pastures. On the island of Nantucket where all the cultivation is in the neighborhood of the different hamlets, it occurs abundantly only in their vicinity, being met with in the open country elsewhere only rarely. It is one of our very commonest butterflies. We have seen, says D'Urban, "more than twenty pitched at the same time on a bush of Michaelmas daisy, and in some parts of Canada the fields look almost yellow with their dancing forms." "Myriads" is the only expression to use, said Henry Edwards, when he saw one day immense swarms next a railway track for the space of a mile; "when disturbed, they flew up in clouds," and nearly all were males.

It collects on damp spots of earth by the roadside or on the brink of pools or streams, particularly in autumn; here it may be found in company with *Cyanirides*, *Melitacidi* and others, sometimes in almost incredible numbers. Mr. Bethune tells how in Canada on the third of August, a lovely, bright, warm morning, after an excessively wet night, he "drove about ten miles along country roads; every few yards there was a patch of mud, the effects of the heavy rain, and at every patch of mud there were from half a dozen to twenty specimens of *philodice*, at least one, I should think, for every yard of distance I travelled. I must then have seen, at a very moderate computation, about ten thousand specimens of this butterfly."

So, too, Gosse writes (*Can. nat.*, 262-263): "I observed, a few days ago, on the public road, great numbers of the clouded sulphur (*Colias philodice*) in flocks of eight or ten, pitched on the patches of wet, slushy mud; they were so closely set together as to make yellow spots, visible a long way off. These little flocks continued at intervals for some miles." D'Urban, Harris, Doubleday, and all recent observers as well, have the same story to tell.

Oviposition. Dr. Asa Fitch makes the following record in one of his note books:—"July 9, 1873. After a cloudy, rainy day, yesterday, the sun comes out bright to-day, and about 9 A. M. I notice two or three of these butterflies, busily ovipositing in front of the office—gently settling down on a clover leaf, for only a moment or two, and then rising and settling on the next clover plant they come to. And if they come to a clover flower, they settle on it a much longer time, and uncoiling their trunk commence sipping the honey, forgetting the work they were engaged about."

He adds that he always finds the egg on fresh, bright green leaves that are rather young and tender, and they are placed toward the centre of the leaf distant from the edge.

Mr. James Angus noticed that in laying her eggs upon clover leaves, the female generally alights on the central lobe facing the apex; then closing her wings she bends her abdomen forward, under the thorax, and deposits an egg, never laying more than one on a leaf; this accomplished, she flies a few yards, then realights to repeat the operation. Only a few seconds, reckoning from the moment of alighting, are required for each deposition, and she lays often about four eggs a minute (P. S. Sprague). If the clover be partially covered with weeds she pushes her way through until she reaches the clover. Mr. Clapp has observed the females thus busy at all hours of the day, from seven in the morning until four in the afternoon.

I have observed that the eggs are laid singly, never more than one upon a leaf, upon or near the middle of one of the halves of the upper surface, in the case of clover leaves. In one instance of 59 eggs laid in confinement by a single female, about one-sixth were laid on the under, the rest on the upper side of the leaves. Riley observed a female laying eggs one "about every minute, always on the upper surface, in the hot sun." On another occasion he observed one laying about two a minute.

Females will lay readily in confinement, and though sometimes a large number may be laid by one in a single day, yet I have found that egg laying was generally interruptedly performed, several days often intervening between batches of eggs, with no apparent cause from the weather; on one occasion one laid two or three eggs daily for five days. This would seem to indicate, what field observation makes more than probable, that the female is usually a fortnight or three weeks in depositing all her eggs.

I have received eggs of this species from Messrs. Angus, Clapp, Sprague, and others. They are erect or slightly inclined upon the leaf, and hatch in from four to ten days, according to the season, usually in five in central New England.

Food plants. The caterpillar feeds upon many species of papilionaceous Leguminosae, but seems to prefer clover, and in my own experience the yellow and white species, *Trifolium agrarium* Linn. and *L. repens* Linn. Mr. Edwards, however, thinks it prefers the red clover, *T. pratense* Linn., and not unlikely it may occur more abundantly on one or the other in particular places. I once found a caterpillar only two or three days old on *Baptisia tinctoria* Brown and raised it on that plant, and found that when in last stage it preferred very dry leaves of *Baptisia* to fresh leaves of white clover; as an individual may thus develop a preference to the food it has always had, so this taste may well be inherited and geographical preferences arise,—the forerunner, it is possible, of strict-

ural variation. It has also been found upon wild lupine, *Lupinus perennis* L., lucerne, *Medicago sativa* Linn., other species of *Medicago*, the ground plum, *Astragalus caryocarpus* Ker, and cultivated pea, *Pisum sativum* Linn. I saw a female lay three or four eggs on a single clump of *Vicia cracca* Linn., and Fletcher reports that the caterpillars were destructive a year ago to the leguminous plants in the seed beds of the experimental farm in Ottawa, "species of *Cytisus*, *Caragana* and allied plants having to be constantly watched and kept clean by the use of hellebore and pyrethrum." Mr. Angus also found an egg on a blade of common grass, and I have seen one also (laid upon the upper surface), but the caterpillar is not known to feed upon it.

Habits of the caterpillar. The escaping larva eats a hole out of the side of the egg, a little below the summit, and afterwards eats a portion more, but, in captivity at least, it does not devour much, never the whole of the egg. The young larvae, says Edwards, "are at first rather difficult to manage, having a disposition to roll off the leaves, and are apt to be lost in the breeding cage. . . . This tendency to drop at the least disturbance the larvae retain till maturity, and it is naturally their sufficient protection against enemies or destruction." The young caterpillar rests upon the midrib of the leaf, more commonly upon the upper surface, with its head indifferently toward the base or the apex of the leaf, and in this position, after the first change of skin, can scarcely be seen, so closely does its color resemble that of the plant. "When first from the egg, each makes for itself a hole in the leaf, and feeds at the edges of this for several days" (Edwards). It devours all but the principal veins, often commencing at the tip, so that when it has reached the base, only the skeleton remains; later it devours the entire leaf. In the final stage, after eating, it rests upon a stalk, with the first two pair of true legs raised from the surface and extended forward. It feeds rather rapidly, sometimes attaining maturity (in New England) in about three weeks; its first stage then only lasts two days; the second four or five, and the subsequent stages progressively longer.

Pupation. Edwards gives the following account of its changes:—

As the time approaches for the change to chrysalis, the larva seeks the protection of some stem, bit of bark, or fence rail, spins a button of pink silk and a light web over the surface of the object, fastens its anal feet in the one and its fore feet in the other, and hangs with its back curved downward or outward. Gradually the markings of the body become obliterated, lost in uniform green. In this condition the larva rests for some hours, then rousing itself, spins a loop of several threads from the base of the feet on one side to a like point on the other, instinctively knowing just how long to make the threads, and presently, seizing the loop in its jaws, manages to throw it partly over the head, and by a great effort works it entirely over and down the back to the fourth segment, and stops exhausted. Some hours pass without any motion, when suddenly the skin splits on the back of the anterior segments and is rapidly shuffled off, exposing the chrysalis, which rests secure on its girdle of silk. (Butt. N. A., II: Collas II, III.)

The girdle of silk is a very slight affair and is found in the pupa crossing the middle of the first abdominal segment.

Life history. It is apparently triple brooded almost or quite throughout its range; the first brood, which is also the least numerous, appears in the latitude of Boston, on warm, sunny hillsides, from April 25 to May 15, the appearance of the insect being more than usually affected by the season. Its average advent is about the 8th of May; along the southern coast of New England it is probably about a week earlier, and still further south never later than April; in Georgia, Abbot reports the capture of a female on March 12. In the southern part of New Hampshire it usually appears about the 13th of May; in Norway, Me., and London, Ontario, about the 18th; in Hallowell and Waterville, Me., and probably in the White Mountains district still later. Jones gives its first appearance one year in Nova Scotia, as June 4. It begins to be common in four or five days, but is not abundant until some time after the appearance of the female, which is a week or ten days later than that of the male. Its period of greatest abundance is toward the end of May, when, on the southern coast of New England, the butterflies begin to look old; early in June only rubbed specimens can be found, which fly in constantly diminishing numbers, sometimes to the end of the month, the females outnumbering the males after the first week; a few females may usually be found when the next brood appears. The females of all the broods apparently begin to lay eggs very soon after eclosion, and continue to deposit them for at least three weeks. These are hatched in five days, and the caterpillars often attain their full growth in three weeks; the chrysalis discloses the butterfly in from nine to eleven days. The appearance of the second brood is varied, like the first, according to the latitude. In the southern parts of New England this brood appears the last week in June; around Boston between the 30th of June and the middle of July (usually during the first week), and here the eggs are laid most abundantly the third week of this month; at London, Ont., it appears at about the same time as near Boston (although Mr. Saunders once found the earliest butterflies as late as August 2); in the White Mountains it appears late in July, when specimens have begun to be uncommon and rubbed further south; perhaps in certain years it may be earlier, for at Tadoussac and Cacouna, Canada, Mr. Saunders once found it common between the 16th and 20th of July, while on the other hand Mr. Bethune reports it as exceedingly abundant at Sault Ste. Marie between the 10th and 24th of August. Is it possible that here there are only two broods? Other reports by Bell, on the lower St. Lawrence, would seem to look the other way, but Jones thinks there are only two in Nova Scotia. This second brood usually becomes abundant in about ten days, and flies until the third brood appears. The advent of the third generation is much less diverse in differ-

ent localities; it occasionally appears as early as mid-August, but is usually a little later and sometimes is not seen until September 3; it soon becomes abundant, is still numerous in the middle, and generally seen at the end of October, and continues until after the first severe frosts; even as far north as Halifax, a few sprightly individuals of both sexes have been seen as late as November 4 (Jones), and Mr. Faxon reports it in the vicinity of Boston on November 18.* The eggs of this brood are laid the last of September, so that the larvae probably hibernate, for at this season they do not mature rapidly; and Mr. Edwards writes from West Virginia, October 24, that the caterpillars in his glass breeding cage are still feeding, and both Mr. Sprague and myself have had similar experiences in Massachusetts.

The pale form of the female is often very common late in the season, although not absolutely confined to the last brood; the only direct records of its early apparition are: for the first brood, March 12, Georgia (Abbot), May 8, West Virginia (Edwards), May 15, Albany (Lintner), May 28, Nantucket (Scudder), June 1, in vicinity of Boston (Merrill), June 1, New Haven, Conn. (Smith); for the second brood: June 20, Albany (Lintner), July 9, Milford, N. H. (Whitney), July 15, vicinity of Boston (Harris); other captures in August (Thaxter, Lintner and Scudder) may belong to the third brood. In Nantucket I have sometimes found it in the last brood more common than the yellow female.

Habits, flight and behavior of the butterfly. Edwards gives an excellent picture of this common butterfly:—

Where philodice is found no one can have failed to notice it, either in garden or field, as it gently flits from flower to flower, or courses along the road or across the meadow, with sustained and wavy flight. It is sociable and inquisitive, and may often be seen to stop in mid-career as it overtakes or meets its fellow, the two fluttering about each other for a moment, then speeding on their ways; or they mount in air, approaching, retreating, with a slow, vertical and tremulous ascent, till the eye ceases to follow them. When the clover is in blossom the meadows are gay and animated with these yellow butterflies, and wherever bright flowers are will surely be seen philodice. On marigolds and brilliant single zinnias they delight to pasture, for they have a keen sense of color. I have known one of them to alight on an amethyst in a lady's ring, after hovering about its wearer so persistently as to attract attention, and it rested some seconds. Doubtless there were puzzled perceptions on sounding that stony flower. (Butt. N. A., II: 110-111.)

Dr. Minot once observed that when searching for its honied food the butterfly most frequently alighted on yellow flowers; and Dr. Packard has recorded that in a field where white asters and yellow golden-rods were abundant, "the yellow sulphur butterfly visited the flowers of the golden rod much oftener than those of the aster," while the opposite was the case with *Pieris rapae*.

It flies with considerable rapidity, in an irregular changing course and

* It is reported as on the wing at Mt. Carroll, Ill., on Dec. 20! (Science News, I: 143.)

with a hurried movement of the wings about one or two feet above the herbage. It is only less active than *E. eurytheme*, and is one of the earliest and latest butterflies of the day. Yet if a cloud suddenly obscure the sun, a field which appeared alive with them a moment before will quickly show scarcely a sign; the greater part will sink down into the herbage.

The yellow phillodice [says De Garmo] will often dart from its flower with great velocity, and make quick sallies at another, either of its own species or of a different species. It will fly about the companion, if that one is not disposed to join in the fun. —If it is, away they will go, tumbling over and over in the air, now receding from each other, now approaching. I have never ascertained if they had any playful touches of antennae, as their motions are too swift for the eye (*Trans. Vass. Br. inst.*, II: 133).

When mates meet they often flutter together, higher and higher, fifty feet or more, always in an inclined direction, the male just above or in advance of his mate; while she flies rather steadily higher and higher, he dances in front of her rising all the time until suddenly, when very high in air, he suddenly darts toward the earth and leaves her to fly calmly down again at her leisure.

Notwithstanding these movements I think they mate upon the ground, for I once saw an evident though unsuccessful attempt in this direction and I have never seen the union effected in the air. In the instance referred to, the male approached the female and the female opened her wings at an angle of about 110° , the fore and hind wings a little parted, and raised her abdomen as high as possible; the male made a sudden dart, like a leap, at the female and then, no union effected, leaped away again and stood aside trembling its raised wings. This was repeated a dozen times, the female remaining most of the time in the same spot. When once united they often fly in the air together, as every observer must have noted, and in this case it is always the male that flies, the female hanging with closed and motionless wings.

Mr. Couper observed in *Anticosti* that when alight upon a flower it lies sidewise as if to receive the warmth of the sun, instead of holding itself erect.

When at ordinary rest the wings are closed back to back, the costal edge of the hind wings reaching the middle of the medio-submedian interspace of the fore wings; the antennae are curved a little at the base, when viewed laterally are raised at an angle of about 15° with the plane of the body, and diverge at an angle of from 110° – 125° .

When at complete rest the fore wings are dropped, bringing the costal edges of all the wings together and the basal half of the inner border of the hind wings parallel with the surface, while the wings diverge at an angle of 20° – 25° . The antennae, viewed laterally, have a gentle arching curve throughout their length; they are thrust horizontally forward side by side, the clubs slightly overlapping; the forelegs project in front and rest upon the ground.

According to Dr. Minot, these butterflies "pass the night among the roots of grass. Toward sunset they become less active and take shorter flights when disturbed; as it grows darker and colder they settle down deeper among the roots and dried grass until it is almost impossible to find them. When evening has come they seem torpid and will allow themselves to be trodden upon or picked up in the fingers. The legs then hang or are folded under the breast, the tarsi of each pair crossed."

Enemies. According to Mrs. Treat, the caterpillars of this butterfly are "greedily sought for and large numbers taken to the nest" of *Formica sanguinea*. (Chapters on ants, 65.) The actual parasites of the insect are many less than would be expected of so common an insect. Fletcher reports the destruction of a larva in a single instance by a Tachinid fly, while, among hymenopterous parasites, *Pteromalus puparum* has been bred from it by Lyman, and a small Braconid by Miss Murtfeldt, *Mesochorus scitulus* Cress., a secondary parasite. Mr. Fletcher also states that toward the autumn of 1887 "large numbers of these caterpillars were found dead in the fields, bearing a cluster of bright yellow cocoons of a small, parasitic, ichneumon fly," which Ashmead named for him *Megoris mus nubilipennis*.

Desiderata. Our knowledge of this insect is comparatively perfect, but its hibernation condition is still undetermined; if the larva hibernates in the ultimate or penultimate stage, the duration of the chrysalis in spring requires investigation. Whether the insect is triple brooded in the extreme north is also doubtful. Mr. Minot's suggestion that the butterfly affects flowers of its own color should be examined. Strange to say, the insect has rarely been found parasitized, which may account for its great abundance.

LIST OF ILLUSTRATIONS.—EURYMUS PHILODICE.

Egg.

- Pl. 65, fig. 25. Plain.
68: 14. Micropyle.

Caterpillar.

- Pl. 72, fig. 3. Caterpillar at birth.
76: 10. Full grown caterpillar.
79: 46. Head, first stage.
47. Head, third stage.
48. Head, fifth stage.
86: 13. Last abdominal segment, beneath.
42. Dermal appendages, first stage.

Chrysalis.

- Pl. 84, fig. 54. Dorsal view.
55. Side view.
87: 4. Ventral view, in front.

Imago.

- Pl. 7, fig. 6. *E. p. pallidice* ♀, both surfaces.
8. *E. p. philodice*, ♀, upper surface.
9. Male, both surfaces.
13: 6. Female, both surfaces.
8. Male, both surfaces.
35: 4, 5. Male abdominal appendages.
40: 11. Neuration.
46: 37. Androconium.
56: 2. Side view, with head and appendages enlarged, and details of the structure of the legs.
61: 9, 10. Neuration of fore wing, ♂, ♀.
General.
Pl. 23, fig. 7. Distribution in North America.



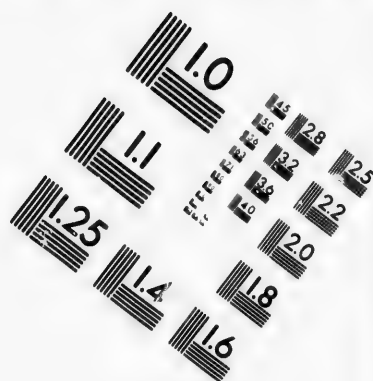
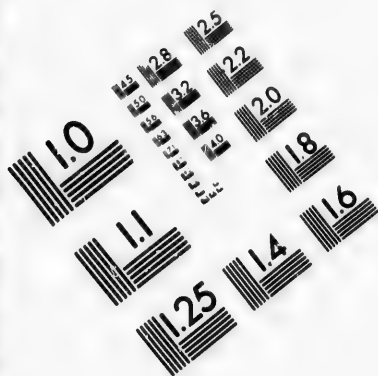
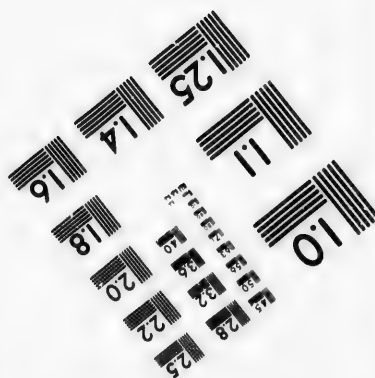
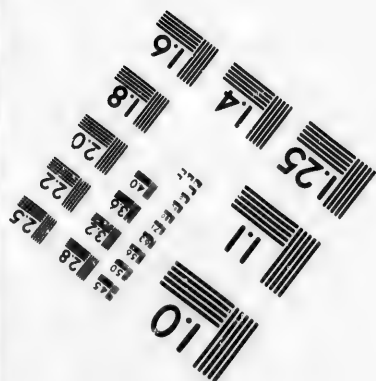
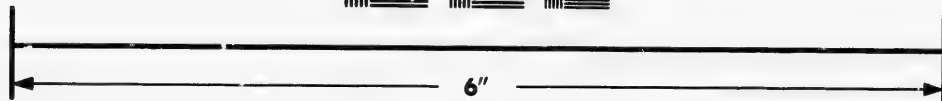
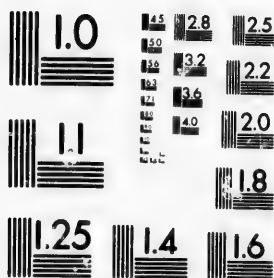


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EURYMUS EURYTHEME.—The orange sulphur.

[The orange sulphur (Scudder); bordered orange and yellow butterfly (Maynard).]

Colias eurytheme Boisdu., Ann. soc. ent. Fr., (2) x: 286 (1862);—Morr., Syn. Lep. N. Amer., 29-30 (1862);—Boll., Tagbl. vers. deutsch. naturf., xlix: 176-179 (1876); Verh. ver. naturw. unterh. Hamb., lii: (1878); Deutsch. entom. zeitschr., xxiv: 241-248 (1880);—Edw., Butt. N. Amer., ii, Col. 4 (1878);—French, Rep. ins. Ill., vii: 147 (1878); Butt. east. U. S., 128-135 (1886);—Middl. Rep. ins. Ill., x: 78 (1881);—Mayn., Butt. N. E., 45, pl. 7, figs. 59, 59a (1886);—Cock., West. Am. sc., iv: 41-42 (1888); Can. ent., xx: 201-201 (1888).

Eurymus eurytheme Scudd., Butt., 303, 309 (1881).

Colias chrysotheme Boisdu.-LeC., Léop. Am. sept., 62-63 (1883);—(pars) Boisdu., Spec. gén. Léop., i: 643-644 (1886);—Morr., Syn. Lep. N. Amer., 28-29 (1862);—Zell., Stett. ent. zelt., xxxv: 437-438 (1874);—Streck., Cat. Amer. macrolep., 83 (1878);—Elwes, Trans. ent. soc. Lond., 1880, 136 (1880); 1884, 6, 16 (1884);—Hagen, Proc. Bost. soc. nat. hist., xxii: 173-174 (1883).

Figured by Glover, Ill. N. A. Lep., pl. 32 figs. 3, 4; pl. M, fig. 8; pl. N, fig. 8; pl. P, figs. 1, 2, ined.

EURYMUS EURYTHEME ERIPHYLE.

The northern yellow type.

Colias eriphyle Edw., Trans. Amer. ent. soc., v: 202 (1876); Bull. U. S. geol. geogr. surv., iv: 514 (1878); Can. ent., xix: 218-220 (1887);—H. Edw., Pac. const. Lep., 123 [24: 7] (1877).

Colias philodice, var. *f.*, *eriphyle* Streck., Cat. Amer. macrolep., 83, (1878).

Colias eurytheme form *eriphyle* Edw., Can. ent., xix: 219 (1887).

Colias eurytheme form *autumnalis* Cock., West. Amer. sc., iv: 42-43 (1888).

Colias hagenii Edw., Pap., iii: 160-161, 163-164 (1883); Can. ent., xix: 170-175 (1887).

Colias barbara H. Edw., Pac. coast Lep., 123-124 [24: 7-8] (1877).

Colias harfordii H. Edw., Pac. coast Lep., 125 [24: 9] (1877);—Edw., Pap., iv: 2-7 (1884); Butt. N. Amer., iii, Col. 2 (1887).

Colias harfordii var. *barbara* Edw., Butt. N. Amer., iii, Col. 2 (1887).

Colias chrysotheme ab. *f.*, *harfordii* Streck., Cat. Amer. macrolep., 83 (1878).

Colias philodice (pars) Hagen, Proc. Bost. soc. nat. hist., xxii: 160, 174 (1888).

Colias interior (pars) Hagen, Proc. Bost. soc. nat. hist., xxii: 165-166, 174-175 (1888).

Colias keewaydin var. *A.* Edw., Butt. N. Amer., i, Col. 4, fig. 7 (1869).

Colias chrysotheme ab. *c.*, *flava* Streck., Cat. Amer. macrolep., 83 (1878).

EURYMUS EURYTHEME ARIADNE.

The southern yellow type.

Colias ariadne Edw., Trans. Am. ent. soc. iii: 12 (1870);—H. Edw., Pac. coast Lep., 121 [24: 5] (1877).

Colias eurytheme form *ariadne* Edw., Butt. N. Amer., ii, Col. 4, figs. 1-6 (1878).

Colias chrysotheme Streck., Cat. Amer. macrolep., 83 (1878).

Colias chrysotheme form *ariadne* Hagen, Proc. Bost. soc. nat. hist., xxii: 173-174 (1888).

EURYMUS EURYTHEME KEEWAYDIN.

The yellow-orange type.

Colias keewaydin Edw., Butt. N. A., i, Col. 4 (1869).

Colias eurytheme form *keewaydin* Edw., Butt. N. Amer., ii, Col. 4, fig. 7 (1878).

Colias chrysotheme var. *d.*, *keewaydin* Streck., Cat. Amer. macrolep., 83 (1878).

Colias eurytheme form *intermedia* Cock., West. Amer. sc., iv: 42-43 (1888).

EURYMUS EURYTHEME KEEWAYDIN**PALLIDA.**

The pale antigenic female of the preceding.

Colias keewaydin var. *B.* Edw., Butt. N. Amer., i, Col. 4, figs. 8-9 (1869).

Colias chrysotheme ab. *e.*, *alba* Streck., Cat. Amer. macrolep., 83 (1878).

Colias eurytheme form *keewaydin*, *pallida* Cock., West. Amer. sc., iv: 42 (1888).

Colias eurytheme form *intermedia*, *pallida* Cock., West. Amer. sc., iv: 42-43 (1888).

EURYMUS EURYTHEME AMPHIDUSA.

The orange type.

Colias amphidusa Boisdu., Ann. soc. ent. Fr., (2) x: 286-287 (1852);—Morr., Syn. Lep. N. Amer., 29 (1862).

Colias eurytheme Edw., Butt. N. Amer., i, Col. 3 (1869);—H. Edw., Pac. coast Lep., 120-121 [24: 4-5] (1877).

Colias eurytheme form *eurytheme* Edw., Butt. N. Amer., ii, Col. 4, fig. 8 (1878).

Colias eurytheme form *typica* Cock., West. Amer. sc., iv: 42 (1888).

Colias edusa Kirt., Faun. bor. Amer., iv: 287-288 (1887);—[D'Urb.,] Can. nat. geol., ii: 314-316 (1857).

Colias edusa var. *californiana* Ménétr., Enum. an. mus. Petrop., i: 80 (1855).

Colias chrysotheme D'Urb., Can. nat., v: 243 (1860).

Colias chrysotheme var. *a.*, *eurytheme* Streck., Cat. Amer. macrolep., 83 (1878).

Figured by Abbot, Draw. Ins. Ga., Gray coll., Bost. soc. nat. hist., 48 (ca. 1800).

EURYMUS EURYTHEME AMPHIDUSA ALBA.

The pale antigenic female of the preceding.

Colias eurytheme var. *A. Edw.*, Butt. N. Amer., i, Col. 3, figs. 5-6 (1860).

Colias chrysotheme ab. *b.*, *alba* Streck., Cat. Amer. macrolep., 83 (1878).

Colias eurytheme form *typica*, *pallida* Cock., West. Amer. sc., iv: 42 (1888).

[Not *Papilio chrysotheme* Esper, nor *Colias philodice* Godart.]

Der Schmetterling ist in die Rose verliebt,
Umflattert sie tausendmal,
Ihn selber aber goldig zart,
Umflattert der liebende Sonnenstrahl.

Jedoch, in wen ist die Rose verliebt?
Das wüsst' ich gar zu gern.
Ist es die singende Nachtigall?
Ist es der schweigende Abendstern?

Ich weiss nicht, in wen die Rose verliebt:
Ich aber lieb' euch all!
Rose, Schmetterling, Sonnenstrahl,
Abendstern und Nachtigall.

HEINE.

A flight of golden butterflies
In slow and airy quiver
Winged downwards.

HARRIET ELEANOR KING.—*The Indian Summer.*

Imago (15:4, 7). Head covered above behind the antennae with dull roseate brownish hairs, with a broad, mesial, longitudinal stripe of yellowish ones; in front of the antennae with yellow hairs slightly tinged especially at tip with dull roseate, at the extreme sides lemon yellow; sides behind the eyes covered with lemon yellow scales, tinged, especially above, with orange. Eyes in life olive. Palpi bright lemon yellow, the apical joint and apical portion of the middle joint strongly tinged with roseate. Antennae roseate pink, the little, naked, luteo-fuscous, ovate longitudinal spots on the inner lower side faintly flecked with whitish above; club brownish roseate above, deep roseate but partially naked beneath, the large apical joint, and sometimes to some extent the penultimate joint, wholly naked and pale dull luteous.

Prothorax covered above with yellowish roseate hairs, in front with a transverse row of greenish yellow ones. Thorax covered above with very pale, yellowish green hairs, at the extreme front tinged with rosaceous; beneath with nearly uniform bright lemon yellow, the coxae sometimes with pink; rest of legs pink, the femora yellow on the outer side and fringed beneath with yellow hairs, the tibiae and tarsi pale beneath. Spines pale luteous; spurs pale luteous, the apical fourth reddish fuscous; claws reddish pink, luteous at base.

Wings above bright (♂) or rather faint (♀) orange; in the fore wings of the ♀ deepest in the middle of the lower half shading into yellow outwardly, in the ♂ having a faint rosaceous reflection. Fore wings with the costal border, at least as far as the upper limits of the cell and sometimes nearly to its middle, rather bright (♂) or rather pale (♀) greenish yellow, at the base tinged with pink, the costal edge more or less flecked with griseous, most distinctly in the ♀; the lower half of the extreme base of the wing, but generally, in the ♀, the whole base as far as the first divarication of the median nervure, considerably begrimed with griseous scales; the tip of the cell is marked by a distinct roundish black spot broader than long, extending from the base of the straight portion of the lowest subcostal nervule nearly, but not quite, to the upper median nervule; the outer border of the wing is margined with an excessively broad black border one and one-half to two interspaces in width and generally obscurely flecked in the ♂ with long and slender, in the ♀ with squarish yellow scales through which the subcostal nervules and occasionally and partially the median ner-

rules cut delicate yellow lines; in the ♂ the inner border of this band is sharply defined and crenulate and, starting from just before the tip of the first superior subcostal nervule runs in a pretty regular arc past the third superior subcostal nervule, at about midway, between its base and divarication, to the lowest subcostal nervule, at about the middle or its apical four-fifths; below this it runs parallel to the outer border as far as the submedian nervule and then curves towards the base, terminating on the inner border as far from the inner border of the band in the interspace above as that from the outer border; in the ♀ the inner border is vaguely defined and is formed of two nearly straight lines bent at a considerable angle at the upper median nervule; the upper starts from scarcely beyond the middle of the outer four-fifths of the costal border, crosses the base of the third superior subcostal nervule and strikes the upper median nervule not far beyond its middle; the lower follows parallel to the outer border of the wing with a considerable bow opening inwards in the medio-submedian interspace and then curves toward the base, though not usually so considerably as in the ♂. Within the border, in the ♀ only and generally nearer its inner than its outer border, are six vaguely defined, pretty large, roundish, yellow spots; those in the lower subcostal and subcosto-median interspaces are nearly confluent, that in the medio-submedian interspace is in the middle of its upper half and in the upper median interspace none is present or only a few scattered scales forming a vague spot. Fringe dull pink on the upper two-thirds of the outer border, with a yellowish extreme base, pale yellow on the lower part. *Hind wings* broadly though not very heavily begrimed with fuscous scales on either, but especially on the lower, side of the median nervure, on the basal two-thirds to three-fourths of the wing; the central spot of the lower surface shows above as a circular reddish orange spot, sometimes accompanied by a smaller one close to the base of the lower subcostal interspace; the outer border is broadly margined, as in the fore wing, especially above, broadest in the lower subcostal interspace, narrowing toward either end, of the same color as in the fore wing; in the ♂ the inner border is irregularly crenulate and reaches from the tip of the costal nervure to the middle of the medio-submedian interspace; in the ♀ its breadth compares to that of the border of the fore wing, but it embraces a series of large roundish spots of the color of the central parts of the wing, so near the interior border as to break it up, and apparently to remove it much nearer the edge of the wing, excepting above the lower subcostal nervule where its real limits can be detected; it has in either part of the wing a vaguely defined limit as in the fore wing and reaches the tip of the costal nervure above and generally dies away before attaining the lowest median nervule below. The inner border as well as to a lesser extent the costal margin is broadly pale greenish yellow, devoid of dark fleckings. Fringe pale yellow, more or less tinged with faint pinkish, deepening into pale pink on the lower half of the wing.

Beneath deep (♂) or pale (♀) lemon yellow, the hind wings in the ♀ sometimes (in Californian specimens) dull, very pale gray green. *Fore wings*: the costal edge pink; costal border broadly, lightly and nearly uniformly flecked with griseous, as far as the tip of the costal nervure, and nearly half way across the cell; similar flecking is found to a greater or less extent in the basal half of the median interspaces and their vicinity; the tip of the cell is marked by a transverse, black patch, rather slender oval in the ♂, broadly oval or triangular its apex outward in the ♀, extending from the subcostal three-fourths of the way to the median nervule, having a white centre, which is almost always linear in the ♂, ovate or triangular in the ♀; parallel to the outer border is a transverse series of usually not very large, blackish brown, vaguely defined, roundish spots, usually more distinct in ♂ than in ♀, situated at two interspaces' width from the outer border in the lower subcostal, median and medio-submedian interspaces, and seldom in the subcosto-median interspace; a continuation of the series, generally absent from the ♀, and not infrequently in part at least from the ♂, is found in the other subcostal interspaces curving strongly toward the base in passing upward, so that all except the lowest of them are almost seated on the costal border. Fringe pink, as far upward as the lowest

median nervule yellow, at least beyond the base, and yellow apically even above this. *Hind wings* with the costal edges pink; at the tip of the cell, next the lowest subcostal nervule, a small, circular or nearly circular silver spot, its diameter about equalling the distance between the bases of the middle and upper median nervules, edged narrowly and equally with dusky ferruginous, in which are scattered a few blackish scales, and this by a broader annulus, nearly as broad as the diameter of the central spot, of dull, dirty orange, in which, and especially at the outer limits of which, are scattered many fuscous scales; just above this, at the base of the lower subcostal interspace, is a miniature spot of the same character when fullest developed, but often reduced to a spot like the outer annulus, either with or without a dark pupil; it usually rests upon the summit of the larger dot, but occasionally it is wholly absent; parallel to the outer border, in all the interspaces opening upon it, and removed from it an equal distance to the similar series of the fore wings, is a curving row of rather small, vaguely defined, equal, dusky spots, having usually a ferruginous tinge, not infrequently reduced to mere points; in continuation with their curve and depending from the costal margin there is a narrow, transverse, dusky or ferruginous, sometimes pinkish bar, reaching to the upper subcostal nervule. Fringe rather pale pink, tipped with yellow on the upper half of the wing, more extensively as the costal margin is approached.

Abdomen blackish, covered profusely above with yellow scales, and toward the base with yellow hairs, on the sides with greenish yellow scales, and beneath with pale, greenish yellow scales and hairs. In the male the hook of the eighth segment (35:6) is scarcely half the length of the remainder of the segment, curved strongly and almost bent in the middle, equal on the basal two-thirds, beyond tapering regularly to a point. Hook of upper organ similar to that of *E. philodice*. Clasps very closely resembling those of *E. philodice*, but not so strongly excised, the upper extremity channelled narrowly and curved more strongly inward.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	24.75	28.	30.	26.25	29.	32.25
antennae.....	9.25	10.	10.25	8.0	9.4	10.25
hind tibiae and tarsi..	7.7	8.	9.25	7.85	8.	9.15
fore tibiae and tarsi..	5.75	6.5	6.75	5.5	6.25	6.5

Described from 10 ♂, 8 ♀.

Dimorphic forms. As only the form *E. e. amphidusa* has been recognized in the east, the above description is based on that only; for the others see the descriptions and illustrations by Edwards. The pallid form of this type may be distinguished thus:

E. E. AMPHIDUSA ALBA. The yellow and orange of the upper surface (excepting the central spot of the hind wings) is replaced by a nearly uniform, sordid white, tinged faintly with greenish, and upon which the griseous flecking is much more conspicuous; the same color is present upon the under surface of the fore wings, excepting toward the apex, which is rather broadly washed with pale canary yellow, a color which suffuses also the whole under surface of the hind wings, dulled by the admixture of griseous scales, thus differing scarcely at all from the normal type.

Egg (65:22). With eighteen to twenty distinct, but very slightly raised and equal, vertical ribs, distant .05 mm. apart at the middle of the egg, the surface between them delicately vermiculate, with long oval impressions, often twice as long as broad, running vertically, and more or less confluent at their ends, and also broken by straight cross lines at an average distance apart of .02 mm., with quadrangular cells. Size and color of the egg of *F. philodice*.

Caterpillar. First stage. Head brownish piceous, the hairs pellucid. Body dull olive green, unicolorous, or the anterior third of the body slightly more dusky than the rest; raised points profusely and regularly distributed, and fuscous or blackish, yet so small as not much to affect the body color; papillae faintly pallid, fuscous

tipped, supporting wine-glass shaped hairs, having a slender stem half as long as the apical expansion, which is itself as broad at tip as long, and longer than the basal papilla; the lower hairs are, however, club shaped. Spiracles fuscous. Legs and prolegs of the color of the body, the apical half of the former more or less deeply fuliginous. Length, 2.25 mm.; breadth of head, .4 mm.; of body, .4 mm.

Second stage. Head and body uniform grass green, the latter with a distinct, slender, pallid, stigmatal stripe, and sprinkled profusely with fuscous points. Papillae numerous, blackish fuscous, surrounded by a pallid aureole, and surmounted by a delicate, straight or scarcely arcuate, black or pallid hair, slightly longer than one of the sections of the segments. Legs and prolegs concolorous. Spiracles pallid, with dark, testaceous rim. Length, 9 mm.; breadth of head, .9 mm.; of body, 1.25 mm.

Third stage. Head grass green, with pale hairs arising from minute black papillae. Body velvety grass green, slightly paler on the sides than on the back, with a faint, darker, dorsal stripe, and a pallid stigmatal stripe, about as wide as the length of the spiracles, broadly bordered below with darker green. The black and white hairs a little longer than one of the sections of the segments, arising from minute black papillae, in a small, pale green aureole. Spiracles luteous. Legs and prolegs pale green, like under surface of body. Length, 12 mm.; breadth of head, 1.4 mm.; of body, 1.5 mm.

Fourth stage. Does not differ from the final stage, except in size. Length, 20 mm.; breadth of head, 1.5 mm.; of body, 3.25 mm.

Last stage (76:1). Head (79:61) grass green, sparsely dotted with minute black papillae, each giving rise to a short, black hair; ocelli pale green, annulate at base with black; mandibles and labrum edged with blackish.

Body grass green, beset profusely with microscopic raised points, which are black tipped, except in circular, often confluent spots, in the centre of each of which arises a black, hair-mounted papilla like those on the head, and about as abundantly distributed; a white stigmatal stripe the whole length of the body, tracked through the middle with an irregular, ragged, discontinuous thread of color, varying from pale lemon yellow to deep orange red, most highly colored in the posterior portion of each segment; sometimes this stigmatal stripe is followed beneath, especially below the highly colored thread, with more or less extended, but generally very slight, inky patches edging the stripe, which serve somewhat to intensify it. There rarely occurs also a moderately distinct, supralateral, pale yellow thread through the whole length of the body, dying out both in front and behind. Legs and prolegs concolorous; claws pale testaceous. Spiracles pale greenish testaceous, with a very fine black annulus. Length, 30 mm.; width of head, 2.5 mm.; of body, 4.5 mm.

Chrysalis (84:53). Throughout pea green, the whole surface vermiculate, and the vermiculations crested with paler green, giving it a more or less hoary aspect, excepting in a broad, suprastigmatal band, which continues over the alar ridge to the basal wing tubercle, and on the top of the frontal tubercle and along a dorsal line, where the crests are either paler or wholly of the ground color; a stigmatal yellow band, as broad as the height of the stigmata, often continued along the under edge of the alar ridge and edging the under surface of the frontal tubercle; wings marked as in *E. philodice*, and with a similar lateroventral row of spots, here blackish fuscous and often enclosed in a moderately broad, reddish fuscous band crossing the fourth to sixth segments, in which black dots are scattered; and accompanied by the single black dot on the same segments, found in *E. philodice*. Length, 22 mm.; breadth, 5.5 mm.; height, 7 mm.

Geographical distribution (25:8). This butterfly, which is a western, as *philodice* is an eastern, species, has a somewhat unusual distribution. As a rule it is more abundant in the Mississippi valley and westward between the annual isotherms of 40° and 65° or 70°. East of the Mississippi

valley it occurs sparingly and disappears entirely at the Alleghanies with the few exceptions which we shall shortly note. In the Mississippi valley, which it shares with *philodice*, it is the prevailing species of the two. It occurs throughout the entire Rocky Mountain district below timber line, above which it is rarely seen (Mead, Snow), though Packard reports a capture as high as 12,000 feet on Arapahoe Peak. To the north its boundaries are somewhat uncertain, but it extends as far on the Pacific coast as Vancouver's Island (H. Edwards), and to the eastward to Dakota (Allen), Milk River, Montana (Coues), Lake of the Woods (Dawson), Nepigon, north of Lake Superior (Fletcher), Sault St. Marie "not uncommon" (Bethune), Moose (Weir), and Albany River, Hudson Bay (Barnston, British Museum), and a specimen has even been reported from the Athabasca region as taken by Geffcken (Strecker). To the east, west of the Alleghanies, it seems to have followed down the St. Lawrence valley, for it is reported from Michigan (Edwards), Bruce Mines, one specimen (Bethune), London, Ont., "occasionally" (Saunders), St. Catherine's Ont., "very rare" (Saunders), Montreal, one specimen (D'Urban, Pearson), Quebec (Thaxter), about twenty miles below Quebec, one specimen (Bowles), Missiquoi Co., P. Q. (Fyles), and Albany, N. Y. (Bailey). Its southern boundaries extend from southern California, San Diego (H. Edwards), through Arizona (Morrison) to southern Texas (Aaron, Lintner), New Orleans, La. (Edwards) and Oxford, Miss. (Edwards); in southern Ohio Dury says it is rare. Mr. Grote saw only a single specimen in Alabama and Gosse does not mention it from that state. East of the Alleghanies it has occasionally appeared, as in Newcastle, Del. (Reakirt), Maryland "once" (Uhler), and Georgia (Abbot).

Single specimens have also been taken a few times in New England: namely, in Norwich, Conn. (McCurdy), Wollaston (F. H. Sprague) and Belmont, Mass. (Maynard), Montpelier, Vt. (P. S. Sprague) and Mt. Desert, Me., "a single specimen seen" (Thaxter).

As regards the distribution of the different forms, *keewaydin* and *amphidusa* with their pallid females appear to range as widely as the species; the yellow forms, however, *eriphyle* and *ariadne*, divide the field between them, perhaps about equally, though it would appear as if *ariadne* were the more wide-spread. Indeed they overlap and mingle in some places. *Ariadne* extends north to Vancouver Island on the Pacific coast, to central Colorado in the Rocky Mountain region, and to Nebraska and Illinois in the Mississippi valley where it begins to assume a form approaching *eriphyle*. *Eriphyle*, on the other hand, reaches south on the Pacific coast as far as southern California, to southern Colorado in the Rocky Mountain region and apparently about to the head waters of the Mississippi in the eastern part of its range.

Food plants. The two buffalo clovers of the west, *Trifolium reflexum* and *T. stoloniferum*, seem to be the staple food of this larva, which readily takes also to white clover, *T. repens*, but refuses the red, *T. pratense*. Behr says it feeds in California on *Trifolium tridentatum* and he also gives *Hosackia* as a food plant. It is further said to feed on two species of *Astragalus*, *A. caryocarpus* and *A. crotalariae*, and a female in confinement laid an egg on *Medicago denticulata*, but it is not stated whether the caterpillar fed on it or not.

Habits of the caterpillar. These do not differ in any special way from those of *E. philodice*. I notice, however, that the action of the full grown larva when on its food plant is singularly like that of *Euphœades troilus*, in that it moves forward in a series of scarcely perceptible starts. The hibernating caterpillars seem, Mr. Fletcher writes me, during the early part of their hibernation, to be in a sort of restless sleep, and though they may remain motionless for days will, if breathed upon, start as if alarmed.

Life history. Mr. W. H. Edwards, who has studied this butterfly most carefully, finds some variation in its life history in different places. Thus among the mountains of northern Colorado, the butterfly is digoneutic, flying in June and again in July and August, and "probably the species is here preserved by the survival of some of the last butterflies" through the winter. In Nebraska and Illinois it is trigoneutic, and both butterflies and larvae hibernate. In the lowlands of California it is either triple or quadruple brooded and the butterflies and probably caterpillars also hibernate, while the upland races are only digoneutic and considerable mixture is the result. In Texas, according to Boll, it flies from November on, but totally disappears in June, and is not seen again until November, and in this short season there are no less than four broods. So, too, the clover that nourishes the caterpillar dies down to the ground before the last butterflies of June appear and only springs up again after the October showers. Probably the hiatus is bridged over by the caterpillars. It would seem that in similar localities the seasons of this butterfly and *E. philodice* almost exactly correspond or it may be the present species is a trifle later. In general it would appear that the egg state varies from four to nine days, the caterpillar may grow to maturity in a fortnight or, not including those that hibernate, may have its stages so prolonged in the latter part of the season as to extend to four or five weeks, and the chrysalis hangs from nine to fifteen days. Eggs laid at Nepigon, north of Lake Superior, on July 10 gave the butterfly at Ottawa, August 13 to September 1.

Habits of the butterfly. The butterfly occurs in open fields. Mr. Thaxter was attracted to the specimen which he took at Mt. Desert by the orange color of the wings, and says that the butterfly was apparently

"dancing a nuptial pas de deux with a companion ; they twirled high into the air beyond reach, but soon separated and came to earth again, when one was captured."

Geddes says that this is one of the liveliest of the Euryimi, the form eriphyle especially being "almost impossible to catch on the wing from its zigzag movement in flying, and its long flights, often flying high in the air." From the few times I have seen this insect in flight I should consider it somewhat but not greatly more active than *E. philodice*. Others habituated to seeing only the latter have been similarly impressed as Geddes. Thus Pearson, of Montreal, "saw something like a flash of orange light flit past him" and described its movements thus : "Away it was flying like a ray of sunlight, flitting from flower to flower, resting only for about the smallest conceivable portion of time." So, too, according to Mr. Bethune, its habits are similar to those of the previous species, but its flight is more rapid ; it scarcely ever rests for more than an instant, and can only be captured after a long and exciting chase.

Polymorphism. With the possible exception of *Cyaniris pseudargiolus*, this butterfly is the most polymorphic yet discovered, the different forms assumed in different localities and at different seasons of the year having been described four or five times as distinct species ; and inasmuch as the species extends over a vast extent of country both latitudinally and longitudinally, its life history is modified to a considerable extent, and a commingling of forms ensues which is often very puzzling to understand. Moreover, while in the north the direct sequence of activities is interfered with by the winter, in the extreme south, on the other hand, by the summer with its blazing sun, which dries up the food plant so completely that were it not for the lethargic powers of the caterpillar, the species must become extinct.

It is difficult to present a picture of so complicated a life history and a polymorphism combined. We shall perhaps get a clearer view of their relations, if we begin our explanation with an account of the condition of things in the extreme south, following Mr. Boll, who first pointed out the direct relationship of several of the forms previously considered distinct species. In his paper read to the Association of German Naturalists at Hamburg in 1876, Mr. Boll states that in the region where he had resided in northern Texas the cycle of changes begins with the appearance of the butterfly upon the wing, generally in November, directly after the more abundant rains of October have caused the leaves of the food plant of the caterpillar again to flourish. During the warm days of winter, fresh examples are frequently found and it flies uninterruptedly until the end of June, is most common in March, in May becomes more rare, and by the end of June vanishes altogether. Before the emergence of the last butterflies from the chrysalis, the running Buffalo clover which forms the food plant of the caterpillar dies to the root. The earliest butterflies which appear up

to the end of February belong to the form *ariadne*, though at the very outset, according to a later communication to Mr. Edwards, a few worn specimens of *amphidusa* may be found in the early part of November. The new brood of butterflies which appears in March is made up of *keewaydin*; while those coming subsequent to this belong to the form *amphidusa*, of which there are at least two broods. To use Mr. Edwards's translation of Mr. Boll's paper, Mr. Boll continues as follows:—

"If we compare the specimens we find a steady increase in intensity of color [and in size] from April to June; the orange-red becomes more fiery and extends in the male over the whole upper surface of secondaries, leaving [sulphur] yellow only the costal margin of primaries, while the black marginal band becomes broader and broader. Through the influence of the sun the whole orange upper side becomes iridescent, with a violet hue, as in the European species, *C. myrindone*. This is particularly noticeable during life, and is very brilliant, but gradually fades in dried specimens. The whole under side changes from greenish-yellow to [sulphur] yellow. . . . The effect of temperature is in perfect harmony with the steady increase in size and intensity of color."

Here, then, during the year which begins in November, we find several broods, the first consisting of *ariadne*, the second of *keewaydin* and the subsequent broods of *amphidusa*, the insect bridging over the intervening space probably in the caterpillar state or possibly in part also by the persistent life of a few butterflies. "If either form," says Edwards, "appears in any degree out of its season, it is not in sufficient numbers to invalidate the rule. The species here is truly polymorphic and seasonally so."

Just what the sequence is in the extreme north Mr. Edwards could probably tell us from the mass of observations which he has obtained in many years, but at the time of the last connected account he has given us of this species, the northern yellow type was still considered a distinct species. Apparently, however, in the Rocky Mountains the earliest brood of the season consists of the form *eriphyle*, which, on higher elevations at least, replaces altogether the form *ariadne* of the south. This is followed in June by a more abundant brood, and in July and August by another brood, and these two broods are restricted, according to Edwards, to "*keewaydin*, and intergrade up to the paler variety of *eurytheme*, but a few individuals are taken which show a tendency to vary in the direction of *ariadne*." But if I understand aright his presentation of the facts and those given by Mr. Cockerell, there are combined with these, toward the cold season, a certain percentage of *eriphyle*, a form which in the north would appear to be found at the two extremes of the cold season, while the more brilliantly colored forms belong to the hotter part of the year. But, according to Mr. Edwards, there is the same sort (but presumably not the same degree) of difference between the autumn and spring forms of *eriphyle* as there is between *ariadne* and *eurytheme*, so that he regards the form *eriphyle* itself as seasonally dimorphic, the difference being that the spring

males are chrome yellow over both wings and have a very uniform shade, while the October males are of a pale color, a whitish yellow, and the hind wings densely dusted with gray. Similar differences appear upon the under side.

In Illinois and Nebraska again the species, according to Edwards, is trigoneutic, but whether eriphyle occurs here does not appear from his statements. The typical ariadne, however, does not appear, though many of the early broods are nearer ariadne than keewaydin. Here, according to Edwards, the species is rather a variable one, like *E. philodice*, than a polymorphic species, and "either form or any variety of either may appear from any one laying of eggs."

In California the admixture is greater probably than anywhere else. For in the lowlands the southern yellow form penetrates as far north as Vancouver Island, while on the higher ground the northern yellow form, eriphyle, penetrates as far south as San Bernadino. In the lowlands, according to the two Messrs. Edwards, the earliest brood, which flies in February and March is ariadne; the second brood, keewaydin, flies in April and continues on the wing throughout the remainder of the season. Eriphyle appears in July and is abundant in August and September, and ariadne again forms, in certain localities at least, a part of every brood. So far as I can discover, eriphyle also appears here to a certain extent throughout the year; but perhaps, as with ariadne, its abundance is confined to the early and late season.

In addition to this great diversity of forms, which vary in different regions of the distribution of the species, a further element of variation appears in an intensified antigeny. The females of at least the later broods (it does not appear that this has yet been discovered in any females of the types ariadne and eriphyle) not infrequently have the same pallid hue that we find in the allied form, *E. philodice pallidice*, and which is a permanent feature in the female of some other types of *Eurymus*.

To sum up, then, we may say that the polymorphism of this species exhibits itself in seasonal distinctions in all the broods excepting the successive broods of the warmer part of the year in the more southern regions, the first brood showing so little orange upon the wings as to closely resemble the allied species *E. philodice* and itself presenting marked differences in the northern and southern extremities of its range; the second brood of a pale orange intensified in the disk of the wings, and the third and later broods, when there are any, of deep orange. Further, that in some parts of its range, these distinctions are well marked, while in others the type characteristic of the earlier broods may reappear in any of the subsequent ones, and especially toward the close of the year, with the advent of the cold season, the spring type may reappear in considerable force. Finally, that in mountainous regions or their near vicinity there is an excessive in-

tergradation of forms, due probably to the intermingling of those which have been born at higher and lower levels.

Enemies. Strange to say, not a single parasite has been reported to attack this common insect; but Cockerell says a large Asilid fly preys upon the butterfly in Colorado.

Desiderata. The principal point which awaits complete solution is the exact relationship of the form eriphyle to this species. That it belongs here is absolutely certain from the breeding experiments of Mr. Edwards, who has solved so many other points in the history of our butterflies. But now that it is known to be a form of this species, its direct seasonal relation to the other forms needs careful investigation both in the north and especially in those southern regions where the two yellow forms, eriphyle and ariadne, come into close conjunction or overlap. This of course can be undertaken only by those on the spot or at least through their aid, and it is recommended that collectors in such districts should forward to Mr. Edwards eggs and young larvae of known parentage with abundance of the food plant. The observations also upon the other forms need to be multiplied in many localities, not the least upon the Pacific coast, in order to clear up the complete history of the species, and to no one better than to Mr. Edwards can be entrusted the working out of these problems in their relation to each other. Careful comparison should also be made between the seasons of this species and those of its allies wherever it is associated with others, as it is indeed with one species or another in nearly every part of its range. Such comparisons are desirable in part to answer questions that may arise concerning the hybridization of this butterfly with its relations. We know too little of the seasons of this species in the most northern parts of its range, where it would seem probable that it must be only digoneutic, so that it is specially desirable that those residing in the Dominion of Canada should follow up the history of this butterfly in their own district in many places. This has partially been done in Nepigon by Mr. Fletcher, but needs to be carried out still more fully. The parasites of this butterfly need to be investigated, or if it really enjoys immunity from them, the cause of such immunity should be sought.

LIST OF ILLUSTRATIONS.—EURYMUS EURYTHEME.

- | | |
|---|--------------------------------------|
| <i>General.</i> | <i>Chrysalis.</i> |
| Pl. 25, fig. 8. Distribution in N. America. | Pl. 84, fig. 53. Side view. |
| <i>Egg.</i> | <i>Imago.</i> |
| Pl. 65, fig. 22. Colored. | Pl. 15, fig. 4. Male, both surfaces. |
| <i>Caterpillar.</i> | 7. Female, upper surface. |
| Pl. 70, fig. 1. Full grown caterpillar. | 35: 6. Male abdominal appendages. |
| 70: 61. Head, fifth stage. | |

TRIBE ANTHOCHARIDI.

ORANGE-TIPS.

Frugalia Hubner.

Pierinae (pars) Swainson; Pieridae (pars)

Duponchel; Pieridi (pars) Stephens.

Light and lovely thing of sky,
 Butterfly!
 Flitting ever amid flowers,
 Fed on buds and dewy showers,
 (Flower thyself, or leaf with wings!)
 Say, what finger rosy-red
 Thy rich color brings?
 Wasn't some sylph that o'er thee threw
 Each bright hue?
 Raised thee from morn's fragrant mist,—
 Bade thee through thy day exist?
 Ah, beneath my fingers prest,
 Palpitates thy tiny heart,
 E'en to death distressed.
 Fly away, poor soul! and be
 Gay and free!
 Thus, no more a worm of earth,
 I shall one day flutter forth;
 And, like thee, a thing of air,
 Clothed in sweets and honeyed dews,
 Each sweet flower's share!

HERDER.—*To a Butterfly.* (Transl.)

Imago. Prevailing colors white, marked with orange, green and black. Front excessively tumid; antennae slender, shorter than the abdomen, the club very distinct, short and rather broad, depressed; palpi very slender, half as long again as the eye, with a thin fringe of very long hairs; apical joint long, basal joint less than half as long as the penultimate. Patagia very small, consisting only of a circular base, produced at the posterior end to a short, blunt, triangular process; third superior subcostal nervure of fore wing with a long fork; costal branch of hind wings straight; androconia broad with parallel or nearly parallel sides, and an angulate, heavily fringed apex; middle tibiae shorter than the femora. Eighth abdominal segment prolonged above as a laminate expansion; hook of upper organ of male large; posterior edge of clasp entire and toothless.

Egg. Tall and slender, tapering somewhat more in the apical than in the basal half, but also below to a considerable extent, both base and summit truncate, the vertical ribs not very numerous, moderately high, sharp and distinct.

Caterpillar at birth. Appendages of moderate length, about as long as the segments, rod like, equal throughout, expanding slightly at tip to a compressed, cup-shaped club, the whole seated on a rather large papilla.

Mature caterpillar. Head of the same width as the body. Abdominal segments divided into seven subsections, covered with numerous minute papillae in transverse rows with short hairs, and a few longitudinally and not transversely ranged, far larger papillae with slightly longer, apically expanded bristles.

Chrysalis. Bent fusiform, tapering very gently toward either extremity, the wing cases protruding beneath to a considerable extent; dorsal region a little flattened, often producing a slight, lateral ridge; prominences of body rounded; under surface bent in the middle, the tongue and antennae only reaching the bend and stopping far short of the end of the wing cases.

The species are not numerous but comprise "some of the most elegant and beautiful butterflies known, though not attaining to any great size"

(Trimen). The fore wings are often somewhat falcate. They are largely an Old World type but the north temperate zone of the New World possesses two or three genera, but none peculiar to it. A single form is found in New England. "Woods and their outskirts are the favourite haunts of the species . . . whose flight is commonly more rapid and long sustained" than that of the *Pieridi* (Trimen).

Excepting by Hübner, no naturalist has before separated this group as one of equivalent value to the *Pieridi* and *Rhodoceridi*. The different genera have usually been classed with the former, midway between which and the latter they really belong. The study of the early stages, however, will speedily convince any one free from the bias of tradition that the separation we here maintain is well founded.

The butterflies of this rather small group, like those of the next tribe, are white marked with black, but they are usually further characterized by "a more or less triangular large patch of bright colour occupying the apical portion of fore wings. The colour of this apical marking is most commonly some shade of bright red or orange, often with a lovely rosy gloss" (Trimen, *Rhop. Afr. Austr.*, 42). This bright colored patch is often confined to the males. It has been suggested on several occasions that the marbled green mottling of the under surface of the wings, also characteristic of this group of butterflies, has for its purpose the better concealment of the insect, as assimilating it to the color of the plants or flowers on which it accustomed to alight; and Kirby suggests that the frequent absence of the orange spot from the tip of the female may be due to its greater need of protection than the male, since this vivid spot would render it too conspicuous; while its absence would render it so like the much commoner white species of *Pieris* that they would not be specially noticed among them.

The butterflies are eminently butterflies of early spring, and what is remarkable is that they are usually single brooded, mature rapidly and by the end of June at latest in temperate regions, or earlier than that further south, are already in chrysalis from which they do not emerge until the following season. In keeping with this their food is usually found to be those cruciferous plants of a similar habit, that is, which fruit early in the season, and then absolutely disappear from sight, dying down to the ground. In one aberrant type, *Zegris*, the caterpillar spins before pupation a gauze-like cocoon.

The eggs are midway in form between those of the *Pieridi* and the *Rhodoceridi*, being less fusiform than the latter and more so than the former, which they most resemble. They are always laid singly.

The juvenile caterpillars have ranged appendages midway in length between the excessively long ones of the *Pieridi* and the excessively short ones of the *Rhodoceridi*; these are all hollow channels and outlets to basal

glands, and persist as such through life, as with the Pieridi. The mature caterpillars apparently always have a broad dorsal stripe and a broad stig-matal stripe of lighter color than the rest of the body and there is great disparity in size between the papillae supporting gland-outlets, which are large, and those which are the base of the simple hairs; the head is ex-ceptionally broad.

The chrysalids are very slender, fusiform and curiously bent in the mid-dle, with protruding wing cases, much like many of the Rhodoceri; and the angles of the body are rounded, but are remarkable for the usually excessive length and slenderness of the frontal tubercle, and the general resemblance of the two extremities of the body.

ANTHOCHARIS BOISDUVAL.

Anthocharis Boisd., Spec. gén. Lép., 1: 556 Midea Herr.-Schaeff., Corresp. zool.-min. ver. (1836). Regensb., xxi: 143 (1867).

Euchloe (pars) Hübner.

Type.—*Pap. genutia* Fabr.

Buds do bloom at April's breath,
Wind and insect loving flower,
When the year awakes from death
These my sweet will take for dower.
She will count them, one by one,
Daisy and anemone —
In the Spring-time new begun
Will she too remember me?
All my year is like the string
Of my lady's rosary,
And my days the beads that bring
Prayers upon the rosary;
If she wreathes her smiles with May,
Whirring snows like flow'rets play;
While, if August in her eyes,
Falling leaves seem butterflies.

A. R. GROTE.—*Rip Van Winkle*.

On hasty wings thy youth is flown;
Thy sun is set, thy spring is gone—
We frolic while 'tis May.

GRAY.

Imago (56: 7). Head not very large, clothed with scales, and, especially in front of the antennae, with exceedingly long, forward projecting hairs, most abundant and longest externally. Front excessively protuberant, the middle projecting far beyond the front of the eyes, the upper surface of the projection not only depressed but a little hollowed, and with a slight longitudinal sulcation, extending nearly to the bot-tom; the upper portion projecting rather broadly between the antennae, where it is broadly rounded transversely, and expands considerably behind them; portion below the antennae of about equal breadth and height and a little broader than the eyes on a front view; upper border slightly rounded off; lower edge very broadly and regularly convex. Vertex depressed above to the same level as the upper part of the front, tumid behind, in all parts surpassing the summit of the eyes, the outer front angles scarcely gibbous and projecting forward but little; excepting at these angles the front border is scarcely convex, sharply defined, scarcely raised above the front. Eyes not large, very little full, naked. Antennae inserted in distinct, rather deep pits, open toward the eyes, separated by the diameter of the second antennal joint; shorter than the abdomen, consisting of about thirty joints, of which nine form an ovate, de-pressed club, more than three times as broad as the stalk, and about three times as

long as broad, increasing very regularly in size, to the third joint from the tip, where it commences to diminish, the last two joints forming a short, bluntly rounded, conical apex; on the middle of the under side is a rather large, median, longitudinal, connected sulcation, beyond the club interrupted at each incisure, and extending more than half way down the stalk. Palpi slender, delicate, projecting horizontally, nearly or quite half as long again as the eye, the last joint about half as long as the penultimate, and longer than the basal joint; joints furnished beneath with a thin fringe of very long hairs, projecting downward and compressed in a vertical plane, excepting on the last joint, where they are recumbent and seem to envelop it.

Prothoracic lobes obsolete. Patagia minute, nearly flat, a little more than half as long again as broad, the basal portion nearly circular, produced posteriorly to a triangular lobe with nearly straight sides, tapering to a very bluntly pointed apex.

Fore wings (40:5) scarcely less than twice as long as broad, the costal margin very slightly convex (♀) or nearly straight (♂), the upper three-fifths of the outer border forming a very large and broad dentation, subfalcate in the (♀); the upper portion, as far as the middle of the lower subcostal interspace, is slightly convex, the apical angle being exceedingly broadly rounded, and the margin having a general direction of 120° with the costal margin; here it recedes suddenly at a right angle and passes, in a rather shallow and broad concave curve, to the middle median nervule, and then recedes again with a full curve to the straight inner margin. Costal nervure terminating somewhat beyond the middle of the costal border. Subcostal nervure with three superior branches, the first arising about the middle of the upper margin of the cell, the second at the apex of the cell; the third beyond the cell but nearer to it than the first branch is, itself forking at a short distance from its origin. Cell considerably more than half as long as the wing, and three and one-half times longer than broad.

Hind wings with the costal margin a little convex at base, beyond straight, the outer margin very strongly and regularly rounded, a very little fuller in the ♂ than in the ♀, the angles entirely rounded, the inner margin nearly straight, slightly emarginate in the middle of the apical half, the angle broadly rounded. Costal branch straight, directed upward; cross veins closing the cell striking considerably nearer the second divarication of the subcostal nervure, than that of the median nervure.

Androconia broad, parallel sided, with a dense and very short fringe at apex.

Fore tibiae as long as (♀) or three-quarters the length of (♂) the middle tibiae; fore tarsi as long as the fore femora and middle tarsi and not much shorter than the hind tarsi; hind femora about four-fifths (♂) or a little more than three-fifths (♀) as long as the middle pair. Femora supplied beneath with a rather thick fringe of long hairs becoming shorter apically. Tibiae armed rather abundantly and irregularly with short and very slender, inconspicuous, nearly recumbent spines, and apparently destitute of spurs. First joint of tarsi equalling the three succeeding combined, the fifth as long as the third, and the fourth scarcely more than half the length of the second; joints provided abundantly with spines, above shorter than below and arranged only in indefinite rows; below with four rows, two on either side, of rather long and very slender, frequent spines, the apical ones of each joint larger than the other, though but slightly; claws very small, but little divaricate, compressed, bifid for two-fifths their length, the upper branch the longer, curved but comparatively little excepting near the tip, the lower the broader, much more curved, both finely pointed; paronychial simple, consisting of a long and slender, lamellate lobe, nearly as long as the claw, fully as broad as the claw at the base, tapering a little, bluntly pointed, concealing most of the claw; pulvillus moderately large, longitudinally quadrate, twice as long as broad, placed at the extremity of a broad, stout pedicel, half as long as the claw.

Abdominal appendages: Upper organ large, long, depressed, the centrum equal, the hook tapering and curved downward; clasps subovate, rather regular, but little convex, directed horizontally backward.

Egg. Subfusiform, but tapering very much more above than below, broadest in the middle broadly truncate at base, narrowly truncate at summit, which is about half

as broad as the base, with prominent, tolerably sharp, vertical ribs and very distinct, straight, raised lines transverse to the interspaces, forming quadrangular cells.

Caterpillar at birth. Head well rounded, a little depressed on the median suture above, smooth excepting for the few minute papillae supporting hairs. Body furnished with several series of large, conical tubercles, rather broader than high, bearing straight, erect, equal bristles which are as long as the segments excepting on the first and second thoracic segments; on the first they are of double length and on the second halfway between the two, and all of those of the first and second segments directed forwards; all are delicately clubbed and support a hyaline droplet of fluid at tip. The tubercles are arranged in a supralateral row, becoming laterodorsal on the ninth abdominal segment, placed anteriorly; a lateral series placed posteriorly; a suprastigmatal series directly above the spiracles; and an infrastigmatal series placed posteriorly.

Mature caterpillar. Head broad, stout, very regularly and broadly arched, with an exceedingly slight incline at the frontal suture; on a side view, appressed below, so as to be of equal depth on the lower two-thirds, roundly retreating above; triangle very broad, reaching to the middle of the upper half of the head; surface moderately smooth except for the short, forward directed, denticle-like papillae which stud the surface infrequently, an open cluster of which on either side of the front above, consisting of about half a dozen, are larger and more conspicuous than the others, while those on the cheeks especially posteriorly are smaller than elsewhere; epistoma exceedingly broad, not very deep, the front scarcely concave, the lateral angles sharp; labrum of the normal width with a moderately deep and round excision in the middle, rounded at the outer corners. Basal joint of antennae very large but low; the second a mere ring; the third cylindrical, not more than half so long again as broad; fourth minute, not so long as half the diameter of the third; the bristle exceedingly long and fine. Ocelli six in number, equal in diameter, the four anterior ones very prominent, subequidistant, separated by spaces about equal to the diameter of any one, forming an arc of a circle whose centre would be half way to the back of the head; the fifth and sixth scarcely elevated above the surface and very inconspicuous; the fifth situated behind and forming an equilateral triangle with the second and fourth, counting from above downward; the sixth behind the second and above the fifth.

Body cylindrical, very uniform in width but falling off above on the last two segments to a very broadly rounded extremity. Abdominal segments divided by distinct transverse creases into seven subsegments, of which the second is nearly twice as large as the others which are subequal among themselves. They are provided with a large number of very minute papillae of varying sizes which are arranged both in longitudinal and transverse rows, the transverse rows directly related to the subsegments, and excepting on the largest subsegment always arranged along the middle of the same; on the larger ones they are more irregular. There are also definite series of very large and high, conspicuous, conical papillae arranged more definitely in longitudinal series, a little irregularly upon the first and second thoracic segments; on the first thoracic segment there is a cluster of three of these papillae in the laterodorsal region, two of them anterior and one posterior; besides which there is a single one a little in advance of the middle, halfway between them and the prothoracic spiracle; on the other thoracic segments there is a transverse series on the larger subsegments of six subequidistant papillae. The abdominal segments have similar papillae in a laterodorsal series placed on the larger subsegment, a supralateral series on the next to the last subsegment, and a laterostigmatal series, scarcely behind the spiracle, besides an infrastigmatal series a little behind the middle, extending also upon the second and third thoracic segments where it is anterior; of these papillae those of the laterodorsal and laterostigmatal series are the larger and all support a slender, tapering bristle, slightly longer than the hairs of the smaller papillae, and trumpet-shaped at tip, supporting a globule of hyaline fluid. Under surface of the first thoracic segment with a pair of large, depending, appressed and transverse sacs, the surface of which is scabrous with minute conical papillae, several times higher than broad; spiracles crateriform, very regular, broad-oval. Legs very large at base, rap-

ldly tapering; claws stout, strongly curved at apex, finely pointed. Prolegs stout, blunt, very short; the hooklets from twenty to thirty in number, arranged somewhat irregularly in a double arcuate row, moderately slender, tapering, slightly arcuate and bluntly pointed.

Chrysalis. Body very slender and attenuated, formed of two elongated, uniform cones obliquely united at their bases at the point where the median gird is placed; no marked distinction between the head and thorax, but the dorsum of the thorax slightly elevated. Frontal projection continuous with the body, forming a long, irregular, tapering, bluntly pointed cone as long as the wing cases. Tongue case terminating shortly before the antennae which extend to the tip of the wings, so that if the position were reversed the chrysalis would rest on the antennal tips. Here the wing cases are bent nearly at a right angle, but are rounded. The wing cases have only a slight, rounded, dorsal carina scarcely noticeable, extending forwards to the basal wing tubercle which is otherwise scarcely distinct. The dorsal portion of the abdomen forms an angle of nearly 150° with the anterior half of the body. The abdomen is rounded, slightly compressed, with no lateral ridge whatever, and tapers more rapidly in the apical than the basal half. Cremaster as in *Euchloe*. Spiracles transversely short ovate, slightly elevated, sublenticular, in a large, smooth, circular field.

This genus, with three species, is found on both sides of the continent of North America between the 35th and 40th parallels and reappears in eastern Asia at the same latitudes. A single species is found in Japan and one on each half of the American continent. The closely allied genus *Euchloe*, much more abundant in species, represents the genus in the north temperate parts of the Old World and is also well supplied with species in the western half of our own country.*

The butterflies are rather small, with subfalcate fore wings, all the wings white above, the outer border touched with black at the nervure tips, especially on the fore wings; the fore wings have also a black spot at the tip of the cell and in the male the whole apex is often orange. Beneath they are white, the apex of the fore wings and the whole of the hind wings heavily marbled with greenish brown and black.

The insects composing this genus are comparatively little known, but the earlier stages of our American species have been described in whole or in part. The species are single brooded and appearing very early in the season fly but a short time. They frequent open woods. The hottest part of the year as well as the whole autumn and winter is thus spent in the chrysalis.

The eggs are slender, tapering at either end but especially above, the base broadly and the summit narrowly truncate, with a dozen or fifteen sharp vertical ribs; they are laid on the flower stocks of slender Cruciferae which mature early and disappear entirely after fruitage.

The young caterpillars are slender, pale green with ranged clubbed hairs on the body, as long as the segments. The mature caterpillars are dark green with pale dorsal and stigmatal bands, a very broad spotted head, sparsely but distinctly papillate, and, besides being covered with sparse pile,

* In this statement I have followed Kirby's division of the species of *Anthocharis*, in his Catalogue of diurnal Lepidoptera, without critical examination of all the forms.

the body has on each side of all the segments four series of low, conspicuous tubercles surmounted by slender short bristles supporting a globule of fluid at tip.

The chrysalids are elongate, slenderly fusiform, with protuberant wing cases and a slender, tapering, pointed, frontal projection as long as the abdomen beyond the wing cases, and sometimes recurved. Their shape is that of two exceedingly slender cones united at obliquely truncate bases, the axis of the anterior half of the body being set at an angle with that of the posterior half. They are green or gray mottled with brown, and differ from those of *Euchloe* in the absence of a suprastigmatal carina on the abdomen.

EXCURSUS XLIV.—PROTECTIVE COLORING IN CATERPILLARS.

There might'st thou sing thy sweet Creator's praise,
And turn at quiet o'er some holy book,
Or tune the accent of thy harmless lays
Unto the murmur of the gentle brook,
While round about thy greedy eye doth look.
Observing wonders in some flower by,
This bent, that leaf, this worm, that butterfly.

PEACHAM.—*Rura mihl et silentium.*

CONSIDERING mimicry in butterflies, we pointed out that it was not the least among the strange elements of that phenomenon that these extraordinary departures from a normal type should be gained purely for protection during the final days of a life, the earlier periods of which were subject to far greater dangers than the later.

When, however, we come to examine the earlier stages themselves, though we shall find, as far as I am aware, no cases of parastatic mimicry, we do find that protective colors and markings, if not striking, are at least very general; so general, indeed, that it might be questioned whether there exists a single one of the caterpillars of our butterflies whose markings do not serve in some special way for its protection.

Lubbock and Weismann have pointed out that caterpillars of *Lepidoptera* generally are green in their earliest stage. This, however, is not universally true. Within the narrow scope of our own butterflies we have many instances in which this is not the case. The caterpillar of *Oeneis macouni* is even brilliantly striped; those of nearly all species of *Papilioninae* are almost black with a white saddle, and there are many others, like *Eurymus* and *Basilarchia*, which, though having certainly a green tinge, are nevertheless so obscured by other colors as to have a dusky effect which is at most only greenish. But the fact remains that as a very general rule, caterpillars of butterflies as well as of moths are when hatched nearly of the color of green leaves, and the various modifications which we find in the mature form of our different caterpillars are assumed during growth.

This change of coloration and of markings which takes place during life is oftenest assumed after the second ecdysis, and, what is noteworthy, it is just then that the size of the caterpillar itself becomes materially enlarged. At the end of its second stage the little caterpillar is rarely more than two or three times as long as at birth, while the rate of growth subsequent to that is so great that in its mature condition, it is ordinarily twenty or more times as long as at birth, and its bulk increases in a far greater ratio. The change of color and of markings has, therefore, direct relations to its visibility, and it is in this later period, even more than in the earlier, that we see how completely colors which are protective have established themselves. It is now that those oblique streaks upon the sides of the body are apt to show themselves, which, as Lubbock has pointed out, diverge from the general line of the body at much the same angle that the nervures of a leaf part from the midrib. Often the color of these streaks is graduated into the ground color in a manner which closely resembles the shadows of a raised vein upon a leaf, and it is only when we examine such objects in free nature that we see how perfect the deception becomes.

As Lubbock has pointed out, longitudinal stripes are very common markings and are most common and indeed almost universal upon such caterpillars as feed upon grasses and other elongated forms of vegetation, while they are comparatively rare upon such as feed upon broad leaved plants. This is well exemplified by a comparison of the caterpillars of our *Satyrinae* and *Pamphilidi* with those of most *Vanessidi*, in the latter of which, though longitudinal markings are not unknown, they are almost invariably broken up or confused with mottlings so as to lose much of their force. The green color of all our *Rhodoceridi* and *Pieridi* also, notably of *Eurema lisa*, which feed upon broad leaved plants and lie exposed upon the surface beside the midrib or prominent vein, conceals them almost completely from view even when the eye is fastened upon them. The long and slender form of *Anthocharis* with its striking longitudinal stripes would seem to render it a conspicuous object, but if seen upon the lank vegetation upon which it grows beside the long drawn seed pods, it would hardly be noticed. Caterpillars like our *argynnids*, which conceal themselves upon the ground, are almost black and can hardly be distinguished excepting when in motion. Even the color of the huge caterpillar of *Jasoniades glaucus* is such an exact imitation of that of the leaf upon which it rests, whose sides it has so turned up that no profile view may be had of it, that it does not readily catch the eye.

The few exceptions we have among our butterfly caterpillars where striking and conspicuous colors obtain are perhaps not easily explained. In some, doubtless, the colors may be regarded as warning colors, indicating the unpalatable nature of the creature, as in the case of *Anosia plexippus*. But there are others, such as *Euptoieta claudia* and *Cinclidia harrisii*,

where we know no reason for holding such a view; and it is a little perplexing when we come to examine the large, naked and exposed caterpillars of our Papilioninae, as of *Laertias philenor*, for instance, its black body with projecting orange points set off vividly against the deep green of the *Aristolochia*, or the gay bodies of *Iphiclides* and *Papilio* with their transverse stripes of brilliant orange, green and black,—it is perplexing, I say, to assert that these are warning colors given to show the inedibility of the caterpillar, possibly indicated also by the nauseous odor of the osmateria, when in two other of our own genera, *Jasoniades* and *Euphroeades*, with the same osmateria, we have *protective* colors of no mean importance. They may, however, be explained, at least in part; for the caterpillars of *Laertias* conceal themselves beneath the broad leaves of *Aristolochia* so as not readily to be found but for the marks of their presence in their droppings; and although one finds it difficult to look upon the colors of *Papilio polyxenes* (the more striking of the other two mentioned) as in any sense protective, it is nevertheless true, as pointed out by Poulton with regard to the similarly colored species, *P. machaon* of Europe, that the protection afforded by the coloring of these insects is "very real when the larva is on the plant, and can hardly be appreciated at all when the two are apart."

Poulton, therefore, distinguishes between general protective mimicry, which, he says, is "such an appearance in an organism that the artistic effect of its surroundings is sufficiently reproduced in it to prevent attention from being attracted when the one is seen in the midst of the other," in fact simply a general harmony with its surroundings; and special protective mimicry, where protection is gained by the acquisition of a special appearance. Slater has urged that gaily colored protected caterpillars feed upon poisonous plants like Euphorbiaceae, Asclepiadaceae, *Aristolochia*, etc.; perhaps experimentation might show how much value there is in this suggestion.

One further point may be alluded to. It is well known that the caterpillars of many species of Lepidoptera are dichromatic in their later life, some of the forms being brown and others green. This has nothing whatever to do with sex or with food, and Poulton argues that in these cases both colors are protective and that the species (though in no way the dichromatic form) is advantaged, because when once discovered by an enemy others of the same color would then be more easily found by this enemy (a reason which would appeal to every field entomologist); so that while one form might suffer, the species would be saved through the escape of the other. Weismann believes that this change has been brought about by natural selection, but Semper urges that selection "could not possibly effect any alteration in the pigment, but could only operate after such a change had actually occurred." Closely allied to this is the well known

fact that in a number of our caterpillars and particularly in those of the Papilioninae, an entire change of color takes place just previous to pupation. The period of pupation is probably the most hazardous for an insect, as far as its active external foes are concerned, it being absolutely helpless in this period and in a very sensitive state. The time required for the change is much greater in any one species than for ordinary ecdysis in the same species; and whatever the purpose of the change in coloration may be, it will hardly fail to be noticed that in general all vivid colors are subdued and entirely neutral tints assumed.

There are many instances among other caterpillars where most extraordinary resemblances are assumed, very probably protective in their nature. Indeed in some of our own swallow tails the markings of the front part of the body may very likely serve to alarm a foe about to attack, as they are really of a very striking nature, especially when the creature assumes the attitude which it does when disturbed. We have, moreover, some caterpillars which possess features of a very surprising character, doubtless for the sake of protection; one of the commonest of which is the striking contrast between creamy white and black, or some other dark tint, which makes the creature resemble the vermiform dropping of a bird! This is true of all our species of *Basilarchia*, of *Polygonia faunus* and, especially in their middle stages, of several of the Papilioninae, such as *Euphœades troilus* and *Heracides cresphontes*.

All these mimetic colors are of advantage only as against their vertebrate enemies. M'Lachlan has pointed out, what every observer must discover, that they give the insect no exemption whatever from the attack of ichneumons,—a fact which is perfectly in accord with our knowledge of the physiology of insect-vision. But as regards their more highly organized enemies, it may indeed be doubted whether there is a single one of our butterfly caterpillars which is not protected by means of its color, either to prevent its being seen or to render it conspicuous. Indeed we are inclined to say with Drummond that "mimicry is not an occasional or exceptional phenomenon, but an integral part of the economy of nature. It is not a chance relation between a few objects, but a system so widely authorized that probably the whole animal kingdom is more or less involved in it." (*Trop. Africa*, 178-179.)

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ANTHOCHARIS GENUTIA.—The falcate orange tip.

[The falcate orange tip (Seudder); white orange spotted butterfly (Maynard).]

Papilio genutia Fabr., Entom. syst., iii: 193-194 (1793);—Abb., Draw. Ins. Ga. Brit. Mus., vi: 20, figs. 79-81 (ca. 1800).

Pieris genutia God., Encycl. méth., ix: 118, 168 (1819).

Libythea genutia God., Encycl. méth., ix, suppl., 806 (1819).

Anthocharis genutia Boid., Spec. gén. Lép., i: 565 (1836);—Morr., Syn. Lep. N. Amer., 20 (1862);—Edw., Butt. N. A., ii, Anthocharis 2, (1878); iii, Anthocharis 1 (1888);—Vreuch, Butt. east. U. S., 118-119 (1886);—Ma., Butt. N. E., 48-49, pl. 8, figs. 66, 66a (1886).

Midea genutia Herr. Schaeff., Prodr. syst. Lep., ii: 16 (1867).

Euchloe genutia Butl., Cat. Fabr. Lep., 214 (1860).

Mneciptum vorax midea Hübn., Samml. exot. Schmett., i, Lep. i, Pap. ii, Gent. iii, Manc. A, vor. b, figs. 1-4 (1806-19).

Euchloe midea Hübn., Verz. Schmett., 94 (1816).

Pieris Lherminieri God., Encycl. méth., ix: 118, 167-168 (1819).

Figure 1 also by Glover, Ill. N. A. Lep., pl. 27, figs. 2, 3 (ined.).

Es regte sich kein Hauch am heissen Tag,
Nur leise strich ein weisser Schmetterling;
Doch ob auch kaum die Luft sein Flügelschlag
Bewegte, sie empfand es und verging.

HEBBEL.

Nor did I wonder at the lily's white,

Drawn after you.

SHAKESPEARE.—Sonnet.

Imago (15: 13, 15). Head covered with a mixture of exceedingly long, dull white and bluish gray or blackish hairs, forming a forward projecting clump, the upper portion of which has the larger proportion of dark, and the sides and under surface of white hairs; summit of head nearly nude but concealed by the forward projecting hairs of the hinder portion and enlivened by a few white scales; behind and above the eyes a mixture of white and black scales, those in contact with the eye mostly white, excepting above, where there are but few white scales; a narrow rim of white scales borders the front of the eyes. Antennae whitish, flecked with black scales above, clustered into a broken median line, which expands upon the club, where it covers the whole upper surface excepting the tip, the white annulations at the tip of each joint, and sometimes a sprinkling of white scales on the outside; the inferior inner surface of the stalk, and the lower surface and tip of the upper surface of the club, are nude and of a greenish yellow color. Palpi covered externally with white scales, with a heavy fringe in front of long, mingled blackish and whitish hairs, mainly blackish externally and whitish internally. Basal half of tongue pale luteous, beyond luteo-fuscous.

Thorax black, covered above with long and profuse hoary bluish gray hairs. Legs pale luteous; femora covered externally with white scales, and fringed with long, whitish and a few intermingled shorter blackish hairs; extremities of the tarsal joints dusky greenish, spurs and spines a little dusky; claws dark reddish at tip.

Wings above dull white, tinged almost imperceptibly with greenish, the markings of the under surface of the hind wings appearing indistinctly upon the upper surface, from the transparency of the wings; extreme base obscured by a profuse sprinkling of blackish brown scales. *Fore wings*: the middle of the outer edge of the cell marked by a small, black spot, its edges powdery; entire apex, in male only, orange, limited interiorly by a powdery border, which runs from the costal border, just within the tip of the costal nervure, in a straight line to the outer border, at the extremity of the middle median nervule; basal two-fifths of costal margin marked with blackish scales, mainly collected into short, transverse streaks, shorter and more distant apically; that portion of the costal and outer border of both sexes, which, in the male, is occupied

by the orange patch, narrowly bordered by scattered blackish scales, which are collected at the nervule tips into blackish spots, sometimes nearly or quite connected, and generally more conspicuous in the male than in the female; tip of the lower median and sometimes of the submedian nervule dotted with black; fringe pale greenish yellow, broadly interrupted with black next the black markings. *Hind wings*: fringe whitish, narrowly interrupted with black at all the nervule tips, where the black occasionally infringes, in the least possible degree, upon the wing itself.

Beneath: *fore wings* white, the outer edge faintly tinted with greenish yellow, the spot at tip of cell and the markings on the basal half of the costal margin as on the upper surface; tips of all the nervules, equally on the costal and outer border, marked by a small triangular, black spot, mostly made up of the fringe; apex, over nearly all that portion, which, in the male, is occupied above by the orange patch, covered with an irregular flecking of dark brown scales, occasionally obscurely clustered; fringe as on the upper surface. *Hind wings* white, the outer border slightly, and the veins still more slightly, suffused with a greenish yellow tinge, and the whole surface profusely sprinkled with light brown and blackish brown scales, never compacted in solid masses, but collected in open clusters, scattered over the whole wing, the darker scales mostly confined to the basal half, the lighter to the apical half of the wing; the darker ones are mostly arranged in straggling, transverse, peppery patches and streaks, the paler ones in broad, dusky blotches, following the nervules; there are also some open white patches, in particular three irregular, generally quadrate ones, at equal distances along the costal border; a long streak follows the middle of the cell and extends a little way beyond it, partially interrupted in the middle from the inner side, and just beyond receiving a diagonal patch on the same side; smaller, irregularly longitudinal, inconspicuous patches occur just above the middle of each of the subcostal and median interspaces, and an inconspicuous one is found in the middle of the medio-submedian interspace, at the first divarication of the median nervule; fringe and spots at tip of the nervules as on the upper surface.

Abdomen black above, flecked with a few white scales and long, delicate, bluish hairs; beneath whitish. Upper organ of male appendages (35:14) not quite reaching the tip of the clasp, the hook as long as the centrum, tapering rapidly on its basal half, beyond but little, pretty strongly arched and pointed. Clasp more than twice as long as broad, tapering and rounded at the extremity, the apical upper portion curved slightly inward, the upper edge a very little concave.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	17.5	18.5	21.	18.	19.25	21.
antennae.....	6.75	7.2	8.25	6.25	6.6	7.5
hind tibiae and tarsi..	3.8	4.25	4.8	4.	4.5	5.
fore tibiae and tarsi..	3.25	3.5	4.	3.5	4.	4.2

Accessory sexual peculiarities. Besides the striking differences between the sexes in the coloration of the tip of the fore wing above, the males have scattered over the wing androconia (46:41) of a very distinct type, formed of a simple lamina with scarcely convex sides, a little more than twice as long as broad, the base abruptly tapering to a slender pedicel, the apex broadly and angularly rounded with a dense, short fringe, the filaments enlarged apically and as numerous as the fine and crowded striae of the lamina.

Egg (65:29). Two and a half times higher than broad, the middle third of nearly equal breadth, with thirteen to fifteen vertical ribs of which only seven or eight reach the summit; cells about three or four times broader than long. Color varying from faint to deep orange. Height, .95 mm.; breadth, .38 mm. The figure on the plate is not slender enough.

Caterpillar. First stage (73:9). Head very pale smoky green, the hinder edge margined very narrowly with black; a few short bristles crowded on papillae scattered sparsely over the front; labrum pale. Body dull amber yellow, a little infus-

cated on the posterior segments, particularly on the last, the tubercles infuscated, the bristles black. Legs and prolegs of the color of the body. Spiracles infuscated. Length of body, 1.3 mm.; breadth, .03 mm.; breadth of head, .035 mm.; bristles, .08 mm. long, .003 mm. broad.

Second stage. Head light brown, a little greenish; one of the tubercles on the middle of the front of each side a little larger than any other. Body light green or green yellow, glossy, uniform, excepting for the presence of numerous, minute, very pale brown, round spots, each supporting a minute and very short black hair. Length, 3.6 mm. (After Edwards.)

Third stage. Head much as before, pale green with two brownish discolorations on the front; two tubercles on the front more prominent than the rest. Body yellow-green, glossy, a yellowish, indistinct, mediodorsal band and a more distinct stigmatal band of white. Length, 6.9 mm. (After Edwards.)

Fourth stage. Head pale green in front, sides whitish, a cloudy brown patch on each hemisphere; three tubercles larger than the rest, two upon the front, one over the ocelli. Body dull yellow green, glossy, a mediodorsal yellow band not always clear, except on the anterior segments, and a whitish or yellowish white stigmatal band. Length, 9.7 mm. (After Edwards.)

Last stage (76: 5). Head (79: 54) pallid with greenish lanky blotches, one large one near the summit of either hemisphere, one occupying the frontal triangle with considerable space on either side of it, and the ocellar field in a narrow band of the same. The papillae are black in the lanky blotches, pallid in the pallid, all the hairs very delicate and white.

Body striped with orange, bluish green, lanky blue, white, olivaceous and pale lemon yellow successively, the white stripe being stigmatal and much broader than the others, reaching on either side the large laterostigmatal and infrastigmatal papillae, the orange dorsal and of similar width to the rest, and the under surface pale bluish green. The papillae of the upper surface large and small are ivory black, set in circular brown fields; all the hairs black. Last segment with a dorsal, rounded, lozenge-shaped, black shield. Basal joint of legs and prolegs pale lemon, remainder pale green. Spiracles white. Surface of body microscopically marked with short, transverse, shallow striae, sometimes degenerating into shallow punctae. Length, 22 mm.; width of head, 2.1 mm.; of body, 3 mm.

Chrysalis (84: 59). Surface of body strongly crinkled, on the anterior half transversely, on the posterior half irregularly but with a decided longitudinal trend; otherwise smooth and glistening with an occasional exceedingly delicate and short, pale hair, scarcely observable. The upper surface of thorax pallid, strongly tinged with greenish yellow distributed more or less in patches and with black flecks irregularly scattered about. Head with its frontal projection almost wholly of a uniform plumbeous brown, a color which is shared by the antennae; wing cases and legs with a more yellowish cast, especially on the apical half; both, as well as all the anterior parts, flecked irregularly and very sparsely with black dots of varying sizes. An oblique, black patch at the base of each tongue-case, diverging posteriorly from each other. The wings also provided in the middle of the upper border with a large, triangular, black patch and across the wing at an equivalent point of the costal margin a transverse and irregular black streak. Between this and the preceding, two narrow, longitudinal, black lines. Abdomen pallid yellow, dull purple in circular pustules around blackish dots, with spiracles bright testaceous. Total length, 20 mm.; in a straight line connecting the tips, 18 mm.; breadth in the middle, 3.25 mm.; at cremaster, .75 mm.

Geographical distribution (26: 3). This butterfly has never been found very abundant, and the memoranda of its capture are so scanty that no exact account of its distribution is possible. It appears, however, to be generally confined to the southern half of the Alleghanian and the

northern half of the Carolinian faunas, from the Atlantic to the southern Mississippi valley. It has been found in nearly or quite all the Atlantic States, from Connecticut to Georgia; the southernmost localities from which it is reported are Savannah, Ga., "rare" (Abbot), Kanawha Co., W. Va. (Edwards), and central Texas at Dallas (Boll), and by the Mexican border (Aaron). West of the Atlantic and north of the Gulf district it has been found only in Illinois (Doubleday, British Museum, Worthington), and in Ohio at Cincinnati, where it is very rare (Dury). The northernmost localities where it has been found outside of New England are Newburgh, N. Y., a few specimens only (Edwards).

Boisduval reports it as found about Boston, but this was undoubtedly by error. For in New England it has been taken only in Connecticut at Greenwich, "common" (Alcott), New Haven (Smith, Harger), New Britain (Hulbert, Seudder), Farmington (Norton), and the tops of the Meriden Hills "abundant" (Smith). It has also been seen upon similar trap hills in the vicinity of Holyoke, Mass. (Waters).

Haunts. Edwards says that in West Virginia it is to be found in cultivated grounds, gardens and meadows; and Aaron that in Texas it occurs on the prairies; but these, I think, must be accidental occurrences. Abbot says that in Georgia it is found in dark woods, Boll found it in low and open timbered land along bottoms in Texas; and at New Britain, Conn., the only place where I have met with the butterfly, it frequents the thinly wooded crests of the trap-ridges in the range south of the town, and though found only in the woods, seems to linger a little in the more open spaces where a bit of sunshine falls upon the ground. When alarmed it invariably flew down the slope into a ravine, the opposite side of which was wooded, never down the equally wooded slope which ended in the open country. Mr. Hulbert, the resident entomologist, has but once found it in the open fields. Moreover, Mr. Schönborn, a Washington correspondent of Mr. Edwards, says he never found the caterpillar in open fields but always "on isolated plants growing in places sparingly covered by large oaks, hickories, cedars, and other trees. So that we must look upon this butterfly as properly an inhabitant of open woods.

Oviposition. The eggs, according to Edwards, are laid upon the flower stalks of the food plant, and Schönborn of Washington, he says, has never found more than one on a plant. The only eggs I found were three upon one plant, laid both on the stem and leaves, but as some hatched in two, and others in three days after finding them, they were doubtless laid at different times, and not another plant of the same kind could be found in the neighborhood; in another instance a butterfly confined on shepard's purse on May 15 laid an egg by the 18th at latest, which did not hatch until noon of the 23d—at least five, and perhaps eight days. According to Edwards, they hatch in four days.

Food plants and habits of caterpillar. The caterpillar feeds upon Cruciferae of a slender habit. Schönborn obtained them about Washington on *Sisymbrium thaliana* (an introduced plant). I found the eggs in Connecticut on *Arabis perfoliata*, and the caterpillars fed readily on *Barbarea vulgaris*; Boll in Texas saw the female laying eggs on *Cardamine*, and I obtained an egg, as stated, from a female confined on *Capsella bursa pastoris*. "The young larva feeds on the flowers and buds, and as these pass away, on the seed pods, usually beginning at the end of the long, slender pod, and eating towards the stem" (Edwards).

Pupation. The larva when changing to pupa constructs a long strand of threads for a loop, which passes over the suture between the second and third abdominal segments; it then releases all hold excepting by the anal prolegs, the others being well withdrawn and the whole body not only free but distant from the surface. Before changing, the wings can be seen to fill the second and third thoracic segments, from the normal point for a spiracle straight down through the thickened part of the legs; the veins arise at the stigmal point (that is, the point where a spiracle would be, were there any on these segments) and reach through two joints of the legs, that is to the equivalent of the whole proleg: in the front wing all the branches of the subcostal and median veins can be traced, excepting the first median nervule, and the relations of the median nervules to each other and to the subcostal are seen to be wholly different from what they are in the fully developed wings. The costal and subcostal nervures of the hind wings can also be seen to be as in the fore wings, and the precostal appears as an independent vein.

In his last account of this butterfly Edwards gives the following observations on the changes undergone by the caterpillar after maturity. (Butt. N. Amer., Ser. iii, Pt. 6.)

After the plant has gone to seed, Mr. Schönborn says it utterly disappears, and the larvae never pupate on the plants, but go to the trunks of the nearest trees and there change in the cracks of the bark, or other protected places. The color of the pupa is such that on an oak it would be almost undistinguishable.

I kept my larvae on growing plants set in a flower-pot and covered by a muslin bag, kept upright by sticks, and one morning chanced on a larva in the act of pupating, almost done, while another was just about to begin. Both were attached by buttons of white silk and by girdles to the same stick. The second one at this time was curved from end to end, the head almost touching the stick. (See cut, 2.) Presently it straightened itself and a creeping movement passed from tail to head in a way to loosen the skin from the body, the larva convulsively throwing itself against the girdle, then to the support (3). These throes soon burst the skin at top, exposing the head, over which the process was bent down, flattened and small (4). When the cast reached the last segment it was thrown to the ground by a rapid twisting movement of the pupa, and afterwards the same continued for nearly a minute, accompanied by a vigorous pushing downward. This double motion fixed the hooks securely in the button, which was forced into a cup shape, so that it quite sheathed the end of the segment and afforded a firm support (7 magnified). I have not noticed this peculiarity in the shape of the button in any other species. It would be useful, consider-

ing that nearly a year must pass before the butterfly will issue. Immediately after the skin dropped the thorax was a little prominent (4); no indication of this had been



given by the larva, and it enlarged almost imperceptibly, while the dorsum remained arched. This was the attitude up to fifteen minutes. At twenty the depth of thorax was .14 inch; the process .1 inch long, .03 wide at base, partly raised, semi-transparent (being hollow, a thin shell), not yet rounded (5); the abdomen and all the dorsum still retained the larval colors, even to the yellow band, every tubercle and spot having its corresponding pale black spot or point; the wing cases and under side of head and the process dark brown. As the depth of the thorax increased the girdle was tightened and the dorsum bent in; and when at thirty minutes the projection touched the stick, the dorsum was bent in at an angle which fell a segment below the girdle. The pupa had thus assumed its final shape (6), the process meanwhile having straightened and rounded, becoming .18 inch long and .06 broad at base. The depth of thorax was now .17 inch. At about twenty-four hours the pupa had assumed its final colors, losing the resemblance to the larva. Fig. 1 represents the attitude of the larva for a time before pupation began. (Cut lent by Mr. Edwards.)

Life history. The life history of this butterfly is extremely simple. It is single brooded and hibernates in the chrysalis state. In the north the butterfly has only been taken in May. It appears with the first foliage, at about the end of the first week in May, varying, of course, with the season, and flies to or nearly to the end of the month, possibly in late seasons a few days into June. It seems to remain on the wing but about three weeks. The eggs are laid certainly within a week of the first apparition of the butterfly, and the caterpillar takes probably a fortnight to mature, the latest date at which caterpillars have been found being June 17, when Mr. Hulbert of New Britain, Conn., obtained five specimens in 1887. Maynard is altogether wrong in saying that the butterfly is double brooded, the first brood appearing in July; at that time all the caterpillars are in chrysalis, in which state they pass the entire hot season and winter.

It would seem as if the season were not greatly advanced in the south, for in West Virginia Mr. Edwards found larvae on May 11, just out of the egg and in the second stage, in neither of which conditions do they live for more than a couple of days; eggs obtained in Washington hatched on the 27th of April, and the caterpillars reached maturity on the 22d of May in Philadelphia. The only other data which we have regarding the seasons in the south are a memorandum by Abbot that the butterfly was obtained in Georgia on the 21st of May, and by Aaron that it was common in Texas in the first week of April.

Flight and postures of the butterfly.—Edwards says "it flies low, swiftly, with a peculiar tremulous motion." This is true as compared with the species of *Pieris* but hardly, so far as swiftness goes, in comparison with *Pontia*. As observed by me at New Britain, I noted that it flies in rather a leisurely fashion, two or three feet from the ground, with a gently fluttering motion and in rather a zigzag course, which is intensified when it is alarmed. It is not difficult to capture even in the thickets if it is approached cautiously, but if any haste is shown on the part of the pursuer, he will find the butterfly careful to increase the distance between them. It appears to be always on the move, and I do not recall seeing it visit a single flower in the two days that I saw it in company with Mr. Hulbert.

When at rest the wings are held erect, those of opposite pairs not touching, the costal edges of the fore wings at right angles to the axis of the body, the antennae spread at an angle of about 80° . On a side view the latter are seen to be slightly arcuate, the apical half about parallel to the axis of the body, the club scarcely curved upward and outward. At more complete rest the wings are brought together and the fore wings sunk behind the hind wings so that the costal edges meet. When walking about, the wings are half opened (the planes at about right angles) and the antennae are then more widely divaricate, say 90° – 100° .

Desiderata. Although the natural history of this butterfly appears to be of the very simplest nature, it has only been known within a year or two; and now there is less than usual that is obscure. It is hardly probable, however, that we have exhausted the list of food plants of a caterpillar so widely distributed, no parasites whatever are known in any stage and it is altogether probable that a careful study of the out-door life of the caterpillar would reveal some interesting habits. We need many more details concerning the geographical distribution of the butterfly.

LIST OF ILLUSTRATIONS.—ANTHOCHARIS GENUTIA.

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| <p><i>General.</i></p> <p>Pl. 26, fig. 3. Distribution in North America.</p> <p><i>Egg.</i></p> <p>Pl. 65, fig. 29. Plain.</p> <p><i>Caterpillar.</i></p> <p>Pl. 73, fig. 9. Caterpillar at birth.</p> <p>76: 5. Full grown caterpillar.</p> <p>79: 54. Head, fifth stage.</p> <p><i>Chrysalis.</i></p> <p>Pl. 84, fig. 69. Side view.</p> | <p><i>Imago.</i></p> <p>Pl. 15, fig. 13. Male, both surfaces.</p> <p>15. Female, upper surface.</p> <p>35: 14. Male abdominal appendages.</p> <p>40: 5. Neurulation.</p> <p>46: 41. Androconium.</p> <p>56: 7. Side view with head and appendages enlarged, and details of the structure of the legs.</p> |
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TRIBE PIERIDI.

WHITES.

Voracia Hübner.
Pierisinae Swainson; Pierinae+Lycaeninae

Swainson; Pieridae (pars) Duponchel; Pieridi (pars) Stephens.

Hedgerows all alive

With birds and gnats and large white butterflies
Which look as if the May-flower had caught life
And palpitated forth upon the wind.

MRS. BROWNING.—*Aurora Leigh*.

Imago. Prevailing colors white, marked with black. Front of head considerably and very regularly tumid; antennae slender, longer than the abdomen, the club very distinct, short and rather broad, depressed; palpi very slender, from one and a half to two times the length of the eye, with a thin fringe of moderately long hairs; apical joint long, basal much shorter than the middle joint. Patagia obpyriform, the base circular, the posterior lobe very short and constricted; third subcostal nervure of fore wings forking at the extreme tip; branch of the costal nervure of hind wings curved strongly outward; middle tibiae of male as long as or longer than the femora. Eighth abdominal segment entire in the male or even notched; hook of upper organ large; posterior edge of clasps entire, toothless.

Egg. Tall and slender, tapering very much more in apical than in basal half, the vertical ribs sharp and distinct, not very numerous, the summit of the egg abruptly truncate.

Caterpillar at birth. Appendages of body very long, much longer than the segments on which they are seated, hair-like, tapering very slightly and expanding delicately at tip into an oval club whose width is about that of the base of the hair.

Mature caterpillar. Head of about the same size as the first thoracic segment. Segments divided into less than six sections; body covered with numerous minute papillae emitting short tapering hairs and also with larger papillae in transverse rows bearing longer hairs either tapering or apically expanded.

Chrysalis. Prominences of the body generally angulated; under surface nearly straight; lateral ridge entirely above the upper edge of the wings. Antennae and tongue reaching the tip of the wings.

The insects of this group are almost always of medium size (occasionally small), and are numerous in individuals, often so much so as to be very injurious to kitchen gardens. At the same time the caterpillars are exceptionally rapid growers and gorge their bodies to repletion, whence Hübner appropriately called the tribe Voracia. They feed principally on cruciferous plants or the immediate allies of that family, but some even on Coniferae.

The wings of the butterflies are much more delicate in structure than is usual with Pierinae, and the front pair is seldom falcate, but rounded, broad and ample. The prevailing color is white marked with black; occasionally yellow varieties make their appearance but these seem to be mostly sporadic. Generally speaking, the flight of the insect is neither so strong nor so rapid as that of other Pierinae, though some species have a bold, swift movement, and nearly all show great power when alarmed.

Very many species of this group are mimickers of other butterflies, especially so those of the genus *Leptalis*, which, writes Bates (*Journ. entom.*, 1861, 230), "was supposed, both by Boisduval and Doubleday, to have a real affinity with the *Heliconidae*, as the species not only resemble that family in shape, marking and colours, but they also have, as Doubleday states, a structural similarity to species of *Ithomia* (a heliconideous genus) in the neuration of the wings. The two groups furnish a most curious instance of deceptive analogical resemblance. There is, in truth, the widest possible difference between the two in all essential characters of affinity—a fact which the careful study of the legs in the *Rhopalocera* will satisfactorily prove. As to the resemblance in the wing-neuration, this character loses its importance on account of its adaptive nature, being dependent on the shape of the wing, habits and strength of flight, and varying consequently in nearly allied genera." None of our species are mimetic.

The eggs, though tall, are not so elongated or fusiform as in the *Rhodoceri*; they are usually laid on the under surface of leaves, never in direct contiguity, though large numbers may often be found on the same leaf, sometimes indeed in open clusters. Thus I once counted seventy-six eggs of *Mancipium brassicae* in a cluster in which the eggs were close together, but with no two of them actually touching. Many caterpillars may consequently be found upon a single plant, though rarely living strictly in society. They are long and very slender and preserve throughout life the trumpet-tipped, hollow bristles found on the body of the young larvae and so generally characteristic of them; up to maturity, too, these bear at their extremity a globule of pellucid fluid which seems to be under the control of the creature. The chrysalides are more or less angulated and always straight, without any protrusion of the wing cases. Most of the species appear to winter in the chrysalis state.

The caterpillars of the European *Aporia crataegi* are said by Boisduval (and Grässner repeats the statement) not only to live in society, but to spin in the autumn a web between the forks of trees or a silken tent, within which they conceal themselves and so hibernate, emerging in the spring by breaking the web, and feeding upon young buds so as sometimes to do great damage. I have, however, seen in the Museum of comparative zoology at Cambridge what purport to be the clustered winter eggs of this species, covered with an enveloping, transparent, jelly-like substance,—much as in the case of some reptiles, and altogether unparalleled, so far as I know, in butterflies.

The caterpillars of this tribe, and particularly of *Mancipium*, have in past times formed part of the pharmacopoeia of Europe.

A fossil butterfly of this group has been found in the European tertiary, belonging, indeed, to one of our own genera; and another has been found in the tertiary of Florissant, Col.

Table of genera of Pieridi, based on the egg.

Upper part of egg beginning to taper at or below the middle.....**Pontia.**
 Upper part of egg beginning to taper well above the middle.....**Pieris.**

No material at hand for a table based on the caterpillar at birth.

Table of genera, based on the mature caterpillar.

Body more or less conspicuously striped with darker and lighter colors; larger hair-supporting papillae broader, often much broader than high.....**Pontia.**
 Body almost uniformly green; larger hair-supporting papillae higher than broad.....**Pieris.**

Table of genera, based on the chrysalis.

Frontal tubercle stout, no longer than broad.....**Pontia.**
 Frontal tubercle slender, very much longer than broad.....**Pieris.**

Table of genera, based on the imago.

Middle of outer half of hind wings with a serrated black band; second superior subcostal nervule of fore wings arising at or beyond the tip of the cell; fore tibiae very much shorter than middle tibiae.....**Pontia.**
 Middle of outer half of hind wings with no transverse band; second superior subcostal nervule of fore wings arising distinctly before the tip of the cell; fore and middle tibiae of equal length.....**Pieris.**

PONTIA FABRICIUS.

Pontia Fabr., Ill. mag., vi: 283 (1807).
 Pieris (pars) Auctorum.
 Synchloe (pars) Auctorum.
 Manciplum (pars) Auctorum.

(Not Manciplum Hüb., nor Synchloe Hüb.,
 restr.)

Type.—*Pap. daptidice* Linn.

And the white butterflies,
 From shade to sun-streak are they glancing still
 Among the poplar-boughs?

HEMANS.—*Flowers and Music.*

Imago (56:5). Head moderately large, clothed with long, erect hairs, longest on the front, where they are ascending. Front tumid, especially in the middle, where it surpasses the front of the eyes; above descending greatly but roundly into the antennal pits and to the middle of the space between the antennae; beyond this it is again slightly, transversely tumid, forming a rounded ridge in opposition to that of the vertex, and from which it is separated by a rather deep, transverse sulcation; the portion below the antennae is considerably broader than high, and fully as broad as the eyes on a front view, the sides diverging upward a little; lower border squarely docked. Vertex longitudinally, equally and regularly arched, passing the level of the eyes throughout, the outer anterior angles produced and considerably elevated as tubercles; anterior border slightly concave, a little elevated, its margin abrupt. Eyes neither large nor full, naked. Antennae inserted with the posterior margin in advance of the middle of the summit, in distinct, deep pits, separated by a space nearly equal to the width of the second antennal joint; a little longer than the abdomen, composed of about thirty-three or thirty-four joints, of which the last eight form a strongly compressed, spatulate club, about five times as broad as the stalk, two and a half times longer than broad, increasing rapidly and regularly in size on the first four joints, the last two forming a broadly rounded apex, scarcely angulated at the tip. Palpi very slender, less than twice as long as the eye, apical and basal joints each three-fifths the

length of the middle joint, the whole rather thinly scaled and furnished beneath with a rounded fringe of very long hairs, compressed in a vertical plane.

Prothoracic lobes obsolete. Patagia very small, broad and short, neither arched nor tumid, consisting of a nearly circular basal piece, with a very short and slender posterior lobe, half as long as the basal portion, bluntly pointed, the sides strongly hollowed at the base.

Fore wings (40:6) fully three-fourths as long again as broad, the costal margin slightly convex at the basal and apical fifth, scarcely bent with the middle portion, which is nearly straight, the outer angle abrupt but softened; outer margin nearly straight and inclined at an angle of 45° with the middle of the costal border, above the middle subcostal nervule receding slightly in a gentle curve; inner margin straight, the outer angle well rounded. Costal nervure terminating a little beyond the middle of the upper border; subcostal nervure with three branches, the first arising shortly before the middle of the outer half of the cell, a little nearer the apex of the cell in the ♀ than in the ♂; the second arising scarcely (♂) or a very little (♀) beyond the tip of the cell; the third at about two-fifths the distance from the apex of the cell to the outer margin, forked at the extreme tip in the ♂. Cell half as long as the wing and nearly four times as long as broad.

Hind wings with the costal margin a little expanded and roundly angulated next the base, beyond gently and regularly convex, the outer angle inconspicuous. Outer margin pretty well rounded, more fully in the ♂ than in the ♀, and with a greater proportional fulness above than below as compared to the other sex. Inner margin nearly straight, the outer angle broadly rounded. Costal branch strongly curved outward from its base; vein closing the cell striking the subcostal nervure a little nearer its second divarication than it does the median nervure beyond its second divarication.

Fore tibiae about three-fifths the length of the middle tibiae; fore tarsi scarcely shorter than the fore femora and more than three-fourths the length of the other tarsi; hind femora five-sixths (♂) or two-thirds (♀) as long as the middle pair. Basal two-thirds of femora with rather a dense fringe of hairs, long at the base of the femora and growing shorter outward. Tibiae furnished rather sparsely on all sides with not long and slender spines, scarcely arranged in definite rows, and at the tip with a pair of moderately long, not very slender spurs. First joint of tarsi a little longer than the three succeeding together, the fifth equal to the second, the third and fourth consecutively a little shorter; all the joints furnished rather abundantly with short and very slender spines, placed in longitudinal rows, of which four are on the under surface, an apical pair on each joint scarcely longer than the rest; claws moderately large, slender, compressed, rather strongly divaricate, gently and regularly curved, bifid nearly to the middle, the upper branch considerably the longer, both finely pointed; paronychiae exceedingly delicate, so as not to be noticed at first sight, consisting of a lamella, broad at base and tapering delicately, not quite so long and partially concealing the claw on a side view, finely pointed; pulvillus wanting.

Second segment of abdomen twice as long as the first and considerably longer than the third; beyond regular, the eighth being equal to the seventh, slightly notched in the middle of its posterior margin above in the male. Upper organ of male appendages pretty large, stout, tapering throughout, curving a little, the hook and centrum about equal, the apex of the centrum bearing beneath a stout, compressed lamina, — the combined lateral arms. Clasps much broader than long, roundly and broadly produced at the upper outer portion, and inclined upward as well as backward.

Egg. Largest at or a little below the middle, and tapering above, at first gradually, afterwards with increasing rapidity, to the truncate summit, which is much less than half as broad as the base, which is itself considerably smaller than the middle of the egg on account of the basal tapering in the lower fourth; interspaces between the eggs broken up by cross lines into quadrangular cells, about twice as broad as high. Only alcoholic specimens seen.

Mature caterpillar. Head moderately small, very regularly rounded, broadest at the upper limit of the ocellar field, but scarcely narrower on the sides above it, scarcely

broader than high, the summit broadly rounded; deepest below the front, scarcely apressed; sutures narrowly impressed, triangle considerably higher than broad, extending about three-fifths way up the front; head covered, especially on upper half, with rather constant, small, conical warts bearing a not very long, moderately stout hair, and, especially on lower half, with numerous minute warts each bearing a not very long, delicate hair. Antennae with the first joint very plump and short, the second exceedingly short, scarcely discernible, the third as large as the second and as long as broad, the fourth exceedingly minute. Ocelli six in number, the four prominent ones arranged exactly as in *Pteris*, with the impressed line in front of them, the fifth behind and a little above the first and as far removed from it as the third from the fourth, the sixth behind the row and at equal distances from the first and fourth, with which it forms slightly more than a right angle. Labrum large and moderately broad, the front excised in the middle by the meeting of the well-rounded curves which border the front of each lateral half. Mandibles rather small, moderately broad, not stout, the edge strongly curved, dentate above, denticulate below, the teeth not very delicate, though small. Maxillary palpi exceedingly short, the joints all much shorter than broad. Spinneret very small, short and tapering.

Body nearly uniform throughout, though tapering to an exceedingly slight degree toward either end, the segments divided by slightly impressed transverse lines into sections, of which there are five on the second and third thoracic and first abdominal segments, six, of which the first is largest, on the second to sixth abdominal segments, three or four only on the seventh and eighth abdominal segments; each section is furnished with a transverse row of small conical warts pretty regularly disposed, each bearing either a short, stout, equal bristle, often scarcely longer than itself and abruptly docked, or a moderately long, tapering hair; besides, the body is thickly clothed with very minute warts, bearing each a short, very delicate hair; the posterior edge of the last segment is produced backward a little at the outer angle and armed with a number of hair bearing warts. Spiracles small, scarcely half as long again as broad. Legs pretty long, stout, tapering, the joints moniliform, the last two a little appressed, the claw very small and delicate, slightly curving, beveled at the base. Prolegs pretty large, moderately stout and plump, tapering somewhat and regularly, each armed at the tip with twenty to twenty-four hooklets, which are not very long, rather stout, tapering, not greatly curved, bluntly pointed and arranged in a double and in the middle of each series a triple row in a gentle curve.

Chrysalis. The head is well rounded, the central prominence conical, bluntly pointed, no longer than broad, stout; the prothorax bears on its anterior edge a pair of small, conical, bluntly pointed, forward directed, subdorsal tubercles, nearly twice as long as broad, projecting over the extreme base of the antennae. Median ridge of thorax high, especially on the mesonotum, where it is pretty strongly compressed and elevated into an angular projection in the middle, the front slope of which is nearly straight, the posterior at a little more than a right angle to it and slightly convex, only a little raised above the direction of the whole dorsum of body behind. The lower surface from eyes to wing tips is nearly straight, continuous with the ventral surface of abdomen; the sides of the wings straight and parallel, the basal wing tubercle much as in *Pteris*, but a little and narrowly protuberant. From the upper border of the eye a slight ridge runs backward in a straight course through the basal wing tubercle toward but not to the upper posterior portion of the wing. First three abdominal segments very broadly rounded above, just within the edges of the wings furnished on either side from the base of the second segment backward with strongly compressed, somewhat divergent ridges, elevated to a little tooth at the anterior limit of the third segment and beyond this forming a distinct and slender but not greatly elevated suprastigmatal ridge reaching to the sides of the cremaster; a median carina, distinct but not greatly elevated on the fourth and succeeding abdominal segments; the sides between the ridges well rounded. Preanal button much as in *Pteris*, the apical tubercles broad oval, greatly depressed and recumbent. Cremaster viewed from above long and rather slender, tapering considerably, twice as long as the medium breadth, channelled longitudinally

with a median groove which widens and deepens apically, making the whole segment appear doubly conical, the two sides extending shortly beyond the middle; on a side view rather slender, equal, bent somewhat downward; the apical field is transverse, slender, hollowed in the middle above, otherwise straight, the hooklets scattered over the whole under surface of the apical edge and above in the middle; the hooklets are rather distant, not long, the stems slender, slight, curved and equal, excepting near the apical portion, which is greatly expanded and domed, curved over as in *Pieris*, but with the sides of the expanded portion curved downwards and angulated.

This genus is common to both worlds and almost exclusively confined to north temperate regions. In the Old World, however, it reappears in southern Africa, a single species having long been known from the Cape of Good Hope. In the New World, on the other hand, it is replaced south of the tropics by a closely allied genus which is rather numerously represented. In both the Old and New World, *Pontia* stretches from ocean to ocean, but in the former it is much more abundant in species. In both it extends from the 30th to the 60th degrees of latitude. Only one species reaches the confines of New England.

The butterflies are scarcely larger than in *Pieris*, but have more pointed fore wings. Like them, they are white but more extensively spotted with deep brown; the fore wings have a broad bar at the tip of the cell and midway between this and the outer border a widely interrupted transverse series of similar but smaller spots; the outer border, especially the upper half, is also more or less distinctly margined with triangular (frequently confluent) spots seated in the interspaces; these occur more often in the female than in the male. The hind wings have similar markings, at least in the female, but they are much less distinct and the extra-mesial band is generally continuous, narrow and zigzag. These markings are repeated, generally less distinctly, beneath.

The species vary in the number of their generations, some being single, some double, and at least one—our eastern American species—triple brooded. The spring generation of the polygeneitic species is always more delicately marked than the later butterflies and has sometimes been described as specifically distinct. The insects winter in the chrysalis state.

These butterflies differ greatly from those of *Pieris* in their rapid and dashing flight; at least this is true of the Alpine species of Europe, which, on this account, is very difficult to capture, appearing suddenly and as quickly passing out of reach. Meyer Dür writes that the flight of the most common European species is just as restless and rapid; and Doubleday remarks: "daphidice and protodice have a quicker flight [than the species of *Pieris*] and the latter [protodice], as far as I have observed, is never seen playing in groups and ascending into the air as brassicae and rapae are often seen to do" (*Gen. diurn. Lep.*, i: 44). The caterpillars feed singly on Cruciferae, sometimes doing considerable damage to cultivated plants, for they are voracious feeders and mature rapidly.

The eggs are somewhat slenderer than in *Pieris*, being tall, largest just below the middle, truncate at both extremities, but fully twice as broad at base as at tip.

The caterpillars are of the same form as those of *Pieris*, but are more distinctly pubescent and are striped longitudinally with alternating and equal dark and pale bands often of highly contrasting and vivid colors.

The chrysalids also resemble those of the genus *Pieris* in their general form, but the back has less prominent angulations on the middle of the thorax and the sides of the abdomen, the frontal projection is less marked, and the color is darker and generally more uniform.

One of the ten fossil butterflies known from the European tertiaries (*Pierites freyeri* Heer) belongs with very little doubt to this genus, and with one exception is the sole representative of the tribe known from the ancient world.

EXCURSUS XLV.—COSMOPOLITAN BUTTERFLIES.

Through the sunny summer sky,	Frightened then by fading light,
Came a smiling Butterfly:	And the softly gathering Night,
Wings that seemed with jewels set,	She would chase the flying Day,
Gleams of rose and violet;	So she stops to ask the way—
Bars of black in velvet fold	Lights upon a swinging nest,
Bright with glints of dusky gold;	"Right or left? which way is West?"
Dancing through the sweet sunshine,	And a young Bird answers low—
Glad with clover's ruddy wine!	"On—towards the sunset's glow!
Stopping just to gayly sip	"But just say, before you fly,
The wild pansy's purple lip,	Is it beautiful—the sky?
Or to softly swing and rest	"Shall I see it, do you know?
On an apple-blossom's breast.	Tell me that, before you go!"
Or to steal the fluffy gold	So, ere her bright wings she spread,
That the buttercups do hold,	This is what she softly said:
Or to watch the blossoming grass	"Yes, oh yes! on some glad dawn,
Ripple, when the light winds pass!	When Night's stars are dimmed and gone,
But, still sailing on and on,	"Look straight up into the sky,
Till she finds the sunshine gone;	Fearless spread your wings—then, FLY!"
So she fluttered from the nest,	
Seeking still the yellow West!	

MARGARET DELAND.—*The Bird and the Butterfly.*

STRICTLY speaking, there is no such thing as a cosmopolitan butterfly; yet there is one species, *Vanessa cardui*, which, as we have seen in an earlier part of this work, may well merit that name, since it is found in every quarter of the globe with the exception of the arctic regions, a part of South America and most of the West India Islands; there are also other butterflies whose recent extension naturally leads to the inquiry what should prevent their spreading over the entire globe, or what are the elements that enable a butterfly to gain and maintain a foothold in so many diverse regions.

Let us look for a moment at the peculiarities of distribution of this nearly cosmopolitan butterfly. It belongs, as we have already pointed out, to a subdivision of the genus *Vanessa*, to which we have applied the name

Neopyrameis, the members of which (with the sole exception of this cosmopolitan member) are all found exclusively in the New World; while the antithetical section, *Pyrameis* (with the single exception again of one member found both in Europe and the United States) is exclusively confined to the Old World. Judging from this fact we may venture to assert with considerable confidence that this cosmopolitan butterfly originated in America. Yet it is just on this continent that its distribution is the most limited! It is known in only a comparatively small portion of South America and occurs on none of the West India Islands, with the exception of Cuba where it is rare. The cause of this limitation cannot be attributed to the food plant of the caterpillar; for the thistles upon which it lives are quite as abundant in these regions as in many others which it has invaded, certainly sufficiently abundant for all its uses. Nor can the heat of the tropics be placed as a difficulty in the way, since there is no place where it flourishes more abundantly than in the tropics and subtropics of the Old World, repeated invasions of Europe by hordes from the south where they had outgrown their opportunities being already on record.

Assuming, then, America to have been its original home, it would seem as if we might fairly conclude that a butterfly of a dominant type, after its distribution in the region of its birth had reached its limits, the balance between the competitors in the struggle for existence being fairly struck, on being introduced into a new world, where it had to contend in the struggle for supremacy with none of the members of its own restricted group, which had stood in its way in its native home, would suddenly find that it had reached a region ready for conquest and would spread therein with such success as to completely overrun that division of the world.

That this is a probable picture of events which actually transpired in this instance, the result of which we see to-day, is rendered more probable by other events which have taken place under our very eyes, which, though not strictly parallel, seem to have a lesson. *Pieris rapae*, originating in the Old World among a circle of relatives far greater than exists in North America, relatives whose natural food plant is precisely its own, has been suddenly transported to America, where the group to which it belongs is much more poorly represented in species, all feeding upon plants of the same family; now though there are among them species of the genera *Pontia* and *Pieris* having intimate relationship with forms which have more or less successfully contended with *rapae* in their own home, the inexperience of the American species with such a rude antagonist has made them no match for it; so that in the mere quarter of a century since its introduction it has spread over half the territory of the United States, doing now vastly more injury than all the others of its own tribe combined and contending with them so successfully that their scarcity where formerly

abundant is everywhere noticed. In this latter instance commercial agencies are amply sufficient to explain the introduction of this butterfly into our country. It is, however, an insect dependent upon a group of food plants which forbid its passage into the tropics and so will prevent its spread over more than the north temperate zone.

It is plain that no butterfly can become cosmopolitan whose caterpillar does not feed upon plants found in all quarters of the globe. Yet this is plainly not a sufficient cause for distribution. As a proof of this it may be pointed out that one of the most polyphagous of our butterflies, *Jasoniades glaucus*, which has an usually extended distribution in North America, where it has several allies, has never become cosmopolitan; while plants to which it might easily adapt itself are found in every quarter of the globe. Moreover, the alliances of the genus are wholly with tropical American forms and its ancestors unquestionably originated in that part of the world. Yet the genus is not found in tropics. Nor has it ever spread to the Old World; at the same time there are other genera of the same tribe, not distantly related, which do possess members in both the New and Old Worlds, whose food is of a much more restricted range; such are the genera *Iphicelides* and *Papilio*.

We have another instance of possible cosmopolitanism which is perhaps more remarkable than any of the others, in the spread, known to be recent, of *Anosia plexippus*, which feeds only upon *Asclepiadaceae*, a group of plants found all over the world in temperate and torrid regions. It is remarkable, because *Anosia* belongs to a section of the subfamily nearly all whose other members belong to the Old World, and yet it is in the Old World that it is now achieving its success. In ancient times, some offshoot of the Old World type found its way to the new continent, spread and multiplied, so long a time ago as to have now become differentiated into several different species and genera, one of which, reintroduced through commercial agencies into the home of its forefathers, bids fair to rival its ancient allies. Here then we have a butterfly which may yet become as cosmopolitan as *Vanessa cardui* is to-day, or only less so from its inability to perpetuate itself in regions with severely cold winters.

I do not find among our butterflies any other which seems to me likely to aspire to similar honor. But it may be pointed out that *Pieris rapae* is by no means so destructive in Europe as is another butterfly of the same group, *Mancipium brassicae*, whose caterpillars, being semigregarious, are capable of much more mischief. Should this butterfly be transported to America (and its chances of such transportation seem to be equally good with those of *Pieris rapae*), it would probably outdo the ravages of *Pieris rapae* and spread as far as it.

Considering the relative abundance in individuals of the species of *Rhodoceri* above that of any other tribe of butterflies, the prevalence of

Eurymi in the north temperate regions and of Callidryades in the tropics of the New World, it seems a little surprising that we have among them no single species which has a range at all extraordinary, and no example of widespread distribution through two hemispheres. At least such must be the judgment of one who cannot look upon two forms having an entirely different development in two hemispheres, as holding any right to be considered otherwise than as now distinct species. But there are others who claim an identity of species between some of the forms of Eurymus on the two northern continents. In one case, indeed, it would appear that one of our common species of Eurymus, *E. philodice*, was introduced by some accident into England, and flourished there for a brief while, but speedily became extinct.

It seems almost equally surprising, considering the dependence of insects upon their food plants, that we find not a single instance of any remarkable distribution among butterflies feeding in their caterpillar state upon Leguminosae or upon grasses, although a very considerable number of butterflies affect these particular groups. It is, therefore, plain that besides the universal distribution of its larval food plant, something more is needed to open before any butterfly the possibilities of a cosmopolitan life.

PONTIA PROTODICE.—The chequered white.

[The chequered white (Scudder); the southern cabbage butterfly (Riley); cabbage butterfly (Ross); bordered white butterfly (Maynard).]

Pieris protodice Boisd.-LeC., Lép. Amér. sept., 45-46, pl. 17, figs. 1-3 (1830);—Boisd., Spec. gén. Lép., i: 543 (1836);—D'Urb., Can. nat., ii: 347-348, pl. 6, figs. 3-5 (1857); v: 243 (1860);—Scudd., Proc. Bost. soc. nat. hist., viii: 180-181 (1861);—Morr., Syn. Lep. N. Amer., 17, 317-318 (1862);—Reak., Proc. ent. soc. Philad., vi: 133 (1866);—Pack., Guide ins., 249-50 (1868);—Riley, Rep. ins. Missouri, ii: 104-105, figs. 72-74 (1870); Am. ent., ii: 77, figs. 53-55 (1870); Rep. U. S. dep. agric., 1883, 114-115, pl. 10, figs. 2-4 (1883);—Glov., Rep. U. S. dep. agric., 1870, 79-80, fig. 38 (3 figs.) (1870);—Benn., Can. ent., ix: 201-203 (1877);—French, Rep. ins. Ill., vii: 141-143, figs. 32-33 (1878); Butt. east. U. S., 107-110, figs. 23-25 (1886);—Thom., Rep. ins. Ill., ix: 25, figs. 5-6 (1880);—Middl., Rep. ins. Ill., x: 76, figs. 7-8 (1881);—Coq., ibid. 178, fig. 74 (1881);—Mayn., Butt. N. Engl., 48, pl. 5, figs. 65, 65a (1886).

Synchlœ protodice Scudd., Syst. rev. Am. butt., 42 (1872).

Pontia protodice Scudd., Butt., 153, figs. 26, 135, 136 (1881).

Papilio ——— Abb., Draw. ins. Geo. Brit. Mus., vi: 19, figs. 77, 78 (ca. 1800).

Figured also by Glover, Ill. N. A. Lep., pl. 2, fig. 6 (3 figs.); pl. 27, figs. 11-12; pl. H, fig. 7 (ined.).

PONTIA PROTODICE VERNALIS.

The spring brood.

Pieris vernalis Edw., Proc. ent. soc. Philad., ii: 501-502 (1864); Butt. N. Amer., i, *Pieris* 2, figs. 1-4 (1871);—Reak., Proc. ent. soc. Philad., vi: 132 (1866).

Pieris protodice var. vernalis Edw., Cat. Lep. Amer., 13 (1877).

Pieris calyce Edw., Trans. A. ent. soc. Ill: 189 (1870).

PONTIA PROTODICE PROTODICE.

The later broods.

Pieris protodice Boisd.-LeC. (as above).

Pieris occidentalis Reak., Proc. ent. soc. Phil., vi: 133-134 (1866);—Mend., Psyche, ii: 184 (1878);—H. Edw., Ent. am., iii: 162 (1887).

Pieris nasturtii Edw., Proc. ent. soc. Philad., ii: 501 (1864).

(Not *Pieris nasturtii* Boisd.)

To the gay gardens his unstaid desire
 Him wholly carried, to refresh his sights:
 There lavish Nature, in her best attire,
 Powres forth sweete odors and alluring sights.

SPENSER.—*Malopotosmos*.

Imago (7: 1, 2; 16: 1, 2). Head covered above with dull, white hairs, scarcely tinged with yellowish and with many intermingled rather longer black hairs, those on the front of the head mostly collected in longitudinal rows directly in front of each antenna; behind the eye furnished with many white scales, mingled above with black. Basal and middle joints of palpi white, the apical half of the middle joint with a median black streak on the sides; apical joint black, white within and on the lower half of the sides towards the base; inferior fringe white, overlaid externally by black hairs which are abundant toward the tip, but disappear before the base. Antennae blackish brown, heavily marked with white, especially on the basal half of each joint outwardly above and on the apical third of the inner and outer side below; beneath naked, luteous, narrowly interrupted at the incisures with white scales; club black, or blackish, its inner edge blackish fuscous, the apical joint whitish, tinged with luteous; tongue blackish fuscous, dark castaneous at the base.

Thorax covered above with pale bluish gray hairs, becoming iron gray at the posterior extremity of the thorax; beneath with dirty white scales and hairs; legs the same, the whitish scales becoming very thin on the tarsi, showing a dull luteo-fuscous base; spines luteous, pale on the tibiae; spurs yellowish, dusky at the extreme tip; claws and other appendages uniform luteous.

Wings above white, occasionally very slightly tinged with yellowish; *fore wings* either flecked at the extreme base more or less heavily with black scales mostly overlaid by white ones, the basal half of the costal border dusted inconspicuously with gray (♂), or flecked not very heavily with griseous at the base of the wings at least as far as the first divarication of the median or even to the extremity of the cell, extending also over the basal half of the costal margin (♀); at the extremity of the cell is a broad, transverse bar, running from the first superior subcostal nervule to the median nervure, its inner edge reaching the very base of the subcostal nervule above and the second divarication of the median nervure below; the nervures are traced in whitish as they pass through it and the vein closing the cell, passing through its middle, is generally flecked with grayish. A little nearer the tip of the wing than the bar just described is a curving broken series of similarly colored, sometimes less distinct markings; the uppermost depends from the costal margin, is parallel to the middle costal bar and reaches fully (♀) or scarcely (♂) to the lowest subcostal nervule; in the ♂ it is generally much less, in the ♀ generally much more than half as broad as the middle costal bar, blacker and yet more powdery in the ♂ than in the ♀, and in the latter extending toward the apex of the wing above the third superior subcostal nervule; in the middle of the outer four-fifths of the upper median interspace and the middle of the outer two-thirds of the medio-submedian interspace are other spots in continuation of this series, besides which there are some clustered scales in the subcosto-median interspace, often absent from the ♂, usually extending nearly across the interspace in the ♀; and in the lower median interspace sometimes, especially in the ♀, a few scales in a slender, transverse line; the spot in the medio-submedian interspace is generally more or less clouded or obsolete in the ♂ and is sometimes extended to the inner border, especially in the ♀, where it often extends along the border toward the base with griseous fleckings; the outer margin is generally marked, especially above, with a most delicate fuscous line and the extremities of the subcostal and median nervules terminating on that margin, excepting the lowest median in the ♂, are bordered rather slenderly or somewhat broadly with blackish (♂), or very broadly so as to become concurrent with blackish fuscous (♀), generally, especially in the ♂, more broadly next the costal than toward the inner border; in the ♂ the spots are sometimes confined to the very apex of the wing and seldom reaches half way to the submarginal spots; in the ♀ they are usually oval or roundish and usually run into the submarginal spots. Fringe white, interrupted at the nervure tips on the upper half of the

wings, especially in the ♀, with blackish brown. *Hint wings* flecked at the base as on the fore wings, but passing in nearly all specimens in a broad stripe along the median nervure beyond the first divarication, more broadly and rather more heavily in the ♀ than in the ♂. Just above the extremity of the upper subcostal nervule, the costal margin is bordered by a few griseous scales, often obsolete in the ♂, generally heavy in the ♀. Excepting these markings and a delicate dusky line often edging the outer border, the wings are generally devoid of markings in the ♂; sometimes, however, a few scattered scales in the costal interspaces and very rarely a few scales flecking the extremities of the nervules mark the position of the markings otherwise peculiar to the ♀, namely, a submarginal zigzag band, occasionally partially obsolete, of the same color as the markings of the fore wings, crossing the middle of the outer two-fifths of the wing, parallel to the outer border, the angulations nearest the outer border occurring on the nervules and there joining a series of marginal spots similar to but rather smaller than those of the fore wings and thus enclosing large pyriform or lozenge shaped white spots; in addition the nervures are sometimes wholly flecked rather broadly but faintly with griseous scales, but most conspicuously in the median area. Fringe white.

Beneath of the same white as the upper surface. *Fore wings* with the nervures on the apical fourth of the wing occasionally broadly, but seldom deeply, tinged with greenish yellow; a slight, similar hue is sometimes found at the tip of the cell; more commonly the same apical nervures are narrowly edged with dusky, although never to the same extent as above; the other markings of the upper surface are repeated beneath, generally a very little more broadly; they are usually less distinct, being more or less sprinkled, excepting the median and sometimes the medio-submedian ones, with whitish scales, occasionally forming in the spot at the tip of the cell a distinct grayish spot within the dark one; outer margin sometimes very narrowly and very inconspicuously edged with grayish. *Hint wings* sometimes wholly immaculate, excepting a few scattered gray scales bordering the pale yellow nervule closing the cell, a faint cluster crossing the upper subcostal nervule just below the tip of the costal nervure and a similar bent cluster a little before the middle of the outer two-thirds of the lower subcostal interspace; usually, however, and especially in the ♀, these latter markings are much more distinct and form a part of a transverse, zigzag series of connected, broad and powdery, arrow-shaped spots, formed either of greenish gray scales or of blackish scales on a greenish yellow ground, subparallel to the outer border, the outer extremities of which reach the border at the nervule tips, and the inner extend along the interspaces more than half way to the extremity of the cell. In addition, all the nervures, especially those surrounding and those parts of the others which lie in immediate proximity to the cell and also the lower median nervule, are heavily bordered with greenish yellow more or less flecked with griseous; sometimes the griseous fleckings alone remain; and between these two extremes there appears to be every grade of variation without reference to geographical distribution; in the specimens which are most heavily marked the outer border is narrowly edged especially near the nervule tips with griseous; fringe white.

Abdomen above black, heavily covered at the base with iron gray hairs and beyond thickly with dull, pale yellow scales; beneath with white scales becoming yellow at the sides. Upper organ of male appendages (35: 17, 18) about twice as long as broad, the hook tapering a little more rapidly than the centrum to a point, reaching the posterior border of the clasps; the latter angularly rounded behind and above, the basal half of the upper border straight.

Measurements in millimetres. Length of tongue, 9 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	22.	23.5	27.5	19.5	25.5	26.5
antennae.....		10.5	12.	9.	10.9	11.55
hind tibiae and tarsi...	5.6	6.0	7.2	5.25	6.75	7.
fore tibiae and tarsi..	4.6	5.	6.	4.35	5.	5.4

Described from 28 ♂, 7 ♀.

Dimorphic forms. The above description is drawn up entirely from *P. p. protodice*. *P. p. VERNALIS* differs in being decidedly smaller, the largest females about the size of the smallest males of *P. p. protodice*, and in the markings, particularly of the under surface of the hind wings; these have all the nervures more broadly and usually more heavily banded with greenish gray, leaving between them only narrow, more or less wedge-shaped bars of white before a sharply serrate, narrow, blackish gray band in the middle of the outer half of the wing, capping marginal, more or less obscure, tall, whitish lunules.

Egg (65:26). Two and a half times higher than broad, of almost equal width from a little above the base to the middle of the upper half, with about thirteen to fifteen vertical ribs, all reaching the summit; surface punctulate. Only alcoholic specimens seen. Distance apart of vertical ribs, .12 mm.; of cross lines, .03 mm.

Caterpillar. First stage. According to French it "is of a uniform orange color, with a black head."

Last stage (76:7). Head (79:49) very pale straw-colored, the posterior half faintly tinged with pale purplish; in the centre of each side a large golden yellow spot; the whole head is dotted conspicuously with smaller and larger blackish ferruginous spots, each encircling the base of a not very long black hair; at the bottom of the triangle four are arranged in a transverse row; antennae pale, the apical half of the third joint infuscated. Ocelli purplish, broadly annulated with black. Mouth parts pale, the tips of the mandibles blackish.

Body: the whole upper surface composed of alternating stripes of bright golden yellow and dark greenish purple, sometimes all of equal width, sometimes the darker bands broader than the others; the yellow colors form laterodorsal and stigmatal bands and there is an infrastigmatal band of the purple color. Beneath dull pale greenish with a faint purplish tinge. The whole body is abundantly sprinkled with larger and smaller black dots, occurring mostly upon the darker ground, each giving rise to a rather short, black hair. Other shorter hairs arise from numerous other minute warts. Spiracles luteous. Legs and prolegs of the color of the under surface, the claws of the former fuscous. Length of body, 21-24 mm.; breadth, 3.5 mm.; breadth of head, 2.25 mm. Described from specimens recently immersed in glycerine.

Chrysalis (84:66, 67). Specimens recently preserved in glycerine are yellowish red, but the original hue, according to Riley, is light bluish gray; the color is more delicate on the wings, fainter and suffused with yellowish on the fifth and succeeding abdominal segments. There is a dorsal yellowish line, distinct and bright on the thorax, faint and duller on the abdomen; there is also a faint, broad, yellowish (buff or flesh color in life) laterodorsal stripe on the abdomen, and the suprastigmatal carinae on the same are distinctly margined with yellow. The body, excepting the appendages, is furnished with scattered, small and not very distinct blackish dots, and with the following larger distinct ones: at the apex of the mesonotal crest; usually one in the centre and one situated anteriorly on or next to the suprastigmatal carina of the fourth and succeeding abdominal segments; a ventral and a lateroventral series, one to each segment; and one at the tip of the dorsal surface of the cremaster. The wings are supplied with faint, fuscous, dendritic markings, the veins marked with distant, distinct black dots; there is a black spot on the basal tubercle, and the joints of the antennae are frequently marked in the same way. Spiracles colorous with the body. Length of body, 17.5 mm.; breadth, 4.5 mm.

Distribution (26:4). The Mississippi valley seems to be the metropolis of this butterfly, but it occurs from ocean to ocean, and in the east throughout most of the Carolinian and Alleghanian faunas. In the Rocky Mountain region and on the Pacific coast a form prevails which has been considered by some as a distinct species, but we believe has not been found in any region where the type does not also occur. On the Pacific coast

protodice is recorded from British Columbia (Edwards) to the San Joaquin valley of California. It has been found in the Rocky Mountain region in Colorado everywhere below timber (Reakirt, Mead),—Middle Park (Putnam), Denver, Georgetown (Mead), Webber Lake and Gray's Peak (Osten Sacken); Spring Lake (Putnam), St. George and Paragonah, (Palmer), Salt Lake (Graef), and to the height of 11,000' in the Wahsatch Mountains, Utah (Shepard), the Big Horn Mountains and Montana (Edwards). In the southwest it has been brought from Arizona (Doll, Mead), central Texas (Belfrage), southern Texas (Aaron, Lintner), and in Mexico beyond our borders at Rio Verde, Hacienda de Bledos and Mount Alvarez (Palmer). It is common all along the Gulf coast, but in Florida (Chapman, Abbot) and even in Georgia (Abbot), is reported as very rare, and it does not appear that it extends any distance down the Florida peninsula. In the northwest it has been found as far north as Belly River, a branch of the Saskatchewan, by Captain Geddes, was brought from Heart River and the Yellowstone in Dakota by Mr. Allen, and found by myself at the mouth of the Red River of the North and in Minnesota. One specimen has even been reported by Jenner Weir as taken at Moose Factory, but perhaps the allied species *nelsoni* was mistaken for it. In northern Wisconsin, according to Saunders, it is "quite common"; in Michigan, "common," very common throughout Ohio. In southern Ontario it was not uncommon a few years ago but has since become a rarity (Saunders), and has even been taken in one instance at Lachine in the vicinity of Montreal by Barnston (fide D'Urban). It was also very common one year at Brockport, N. Y. (Bruce), but east of the Alleghanies it occurs more sparingly. It is, however, said to be "usually common" in eastern Maryland (Uhler), and "common" about Philadelphia (Blake); in New Jersey it is reported from Schooley's Mt. and Redbank (Reakirt), and in New York has been taken on Staten Island (Davis), Long Island (Graef, Akhurst) and once in Newburgh (Edwards).

It is now and then seen in New England and is occasionally common in some of the warmer parts; thus Mr. Emery states that it is "sometimes abundant" about Springfield, Mass. where Dr. Dimmock has taken it, and Prof. S. I. Smith has found it not very uncommon about New Haven, Conn. It has also been reported from Plantsville (Shepard, Mus. Yale Coll.) and Blanford, Conn. (Hammer teste Faxon), Newport, R. I. (Higginson), Holyoke "rarely" (Dimmock), Boston (Scudder), Braintree (Uhler, Mus. Comp. Zool.) and Belmont, Mass. (Maynard).

Abundance and haunts. It is the common white butterfly of Missouri, wrote Mr. Riley in 1870, "sometimes flitting so thickly around the truck gardens near large cities as to remind one at a distance of the falling of snow. It often proves exceedingly injurious." But writing again five years ago he says that *Pieris rapae* has now taken its place: indeed it has

suffered at the hands of this interloper equally with the nearer relative of the latter, *Pieris oleracea*. In the west, where only I have seen it abundant, it flies about the low weeds of pastures, waste land and open prairies, but seeks the cultivated field for egg-laying and is fond of the flowers of buckwheat.

Food plants and habits of caterpillar. The caterpillar has been raised by Mr. Saunders upon cabbage (*Brassica oleracea*) and by Dr. Chapman upon wild peppergrass (*Lepidium virginicum*); it undoubtedly feeds also on other Cruciferae, for Boll states that in Texas it feeds from April to July on a species of *Thlaspi* and turns to the cultivated plants only after the death of the former; and Dr. Kirtland remarks that "cabbage or turnip fields, or waste grounds overrun with the shepherd's purse" (*Capsella bursa-pastoris*) are the usual resorts of the butterfly. Glover records it on turnip and Bean on mustard. Riley states that it appears to confine its ravages more closely to the cabbage than our other white butterflies, "but is occasionally found feeding upon the turnip." He has also found it doing great injury to sweet alyssum, *A. maritimum*, "commencing at the head and eating down to the base of the plants. We have also found it feeding on mignonette." Mr. Riley once found a chrysalis "fastened to a stalk of the common horse nettle (*Solanum carolinense*) which was growing in a cemetery, with no cabbages within at least a quarter of a mile"; doubtless it had fed on other Cruciferae. Mr. Beutenmuller tells me that he has taken it at Camden, N. Y., on a species of *Erigeron*, one of the Compositae!

French says that the larvae attack only the outer leaves, never the heart of the cabbage, and thus are less destructive than the caterpillars of *Pieris rapae*.

Life history. The insect is triple brooded, each successive generation more abundant than the preceding. The first, indeed, is seldom noticed, the only memoranda of its appearance being in captures in southern Utah by Palmer in April and May, a note by Abbot stating that he took a specimen on May 13, and in Edward's remarks on *Pieris vernalis* (which is now known to be simply the vernal brood of this species), where he states, "I have taken this species at Coalburgh [W. Va.], in the month of March, it being one of the earliest butterflies of spring." Mr. Bean of Galena, Ill., however, speaks of a spring brood in May as extremely rare. The second brood appears late in June or early in July (Bean says a few may be seen in Illinois about mid-June and a larger brood in July) and continues until the third brood makes its advent—the last of August; early in September this becomes abundant, and the butterflies continue to emerge from the chrysalis even into October and fly, at least in the southern states, into November. The precise times of the appearance and duration of the insect in its earlier stages are unknown, excepting that

Bean obtained eggs August 21, which hatched in four days and gave butterflies by the middle of September, so that the different stages are quickly passed. The insect hibernates in the chrysalis state.

Dimorphism. It is now known that the smaller and more lightly marked and much rarer *Pieris vernalis* of Edwards is only a dimorphic form of the long known *Pontia protodice*. Like the spring types of the genus *Pieris* the color of the wings is of a less pure white and especially are the nervures of the under surface of the hind wings more heavily marked. Boll, Riley, and Bean have all proved the relationship between these forms by breeding, Mr. Boll in the first instance, but Mr. Bean has further shown that the butterflies appearing latest in the autumn when the nights become cool, and from then until severe frosts, "progressively approach *vernalis*," and he concludes from his breeding experiments that *vernalis* "is not a variety abruptly contrasting with a type form, but merely the extreme term of a series of variations departing from type." Boll also states that in Texas *P. p. protodice* is found from April to September but that the caterpillars found in October all develop in November and December into *P. p. vernalis*. Doubtless in Texas also the latter form will be found to fly before April and that in the early spring no other type will be found. For this has been the invariable (though limited) experience everywhere, and the premature development of some of the spring type in the autumn as shown by Boll's and Bean's breeding experiments, is what occurs, though certainly in far less considerable proportions, in other dimorphic species.

Miscellaneous. The flight of the butterfly is rapid, especially when alarmed.

Dr. Hoy once found a female of this species paired with *P. rapae*. She laid eggs on the mustard plant in which the pair was found, and the eggs hatched; but the larvae were never carried to maturity and unfortunately no notes of what the caterpillars were like have ever been published. It was a rare chance lost.

Parasites. None whatever were definitely known until within a recent time; but I have a chrysalis from which a tachinid fly has emerged; and I had heard of its being attacked by ichneumons before the appearance of the following passage by Mr. F. M. Webster, who records the action of *Pteromalus puparum* (89: 1, 2):—

On the morning of August 9 we observed a larva of *Pieris protodice* Boisdu., in the act of transforming to the chrysalis. Near by, and very evidently watching this transformation, were a male and female of this parasite. The trio were observed several times during the early part of the day, the parasites always on guard, as it were, although the female was several times observed to attempt oviposition, in every case, however, being deterred from doing so by the jerking of the larva, now in a semi-pupal state. During one of these visits the male was driven away, but soon returned. About 6 p. m., the last observation of the day, the transformation of the larva, while not complete, had so far advanced as to prevent the radical movements which had characterized its struggles during the forenoon, and the female was busily

engaged in her work of oviposition, the male still present as a spectator (?). On the morning of the 10th the chrysalis, now fully developed, was removed and placed in a glass jar, awaiting further developments. On the morning of the 27th, seventeen days after, the adult *Pteromalus* were observed issuing from the chrysalis in great numbers. After all had emerged, they were counted and found to number 68 males and 4 females. The same parasite had been reared from a similar chrysalis on August 13, but the individuals were not counted. (Insect life, 1: 225.)

Desiderata. It is hardly creditable to us that a butterfly so extremely common as this at least has been, and indeed still is in certain localities, should be so imperfectly known. The egg has never been properly described, nor the earlier stages of the caterpillar. The duration of each of the earlier stages in the different broods has never been stated. There is not even any good description extant of the mature caterpillar or of the chrysalis drawn from the living specimens, that is, one sufficiently complete for comparative purposes. The seasons of the butterfly and the various broods are very imperfectly known, and there is a perplexing problem to solve in the difference between this butterfly and others in the excessive rarity of the earliest spring brood. Perhaps the more frequent appearance of the spring type late in the autumn is correlated with this scarcity. At any rate this is an important problem to be solved. The flight and postures of the butterfly have never been described, nor are all the parasites definitely known. The relation of this butterfly to *Pieris rapae* needs the same careful study that we shall point out as requisite in following out the history of *Pieris oleracea*. Its relation to the western types of *Pontia* still require investigation. Its parasites have been only partially determined.

LIST OF ILLUSTRATIONS.—*PONTIA PROTODICE*.

General.

- Pl. 26, fig. 4. Distribution in North America.
89: 1-2. *Pteromalus puparum*, a parasite.

Egg.

- Pl. 65, fig. 28. Plain.

Caterpillar.

- Pl. 76, fig. 7. Full grown.
79: 49. Head, fifth stage.

Chrysalis.

- Pl. 84, fig. 66. Dorsal view.
67. Side view.

Imago.

- Pl. 7, fig. 1. *P. p. protodice* ♂, both surfaces.
2. *P. p. protodice* ♀, both surfaces.
16: 1. Female, upper surface.
2. Male, upper surface.
35: 17, 18. Male abdominal appendages.
40: 6. Neuration.
56: 5. Side view, with head and appendages enlarged, and details of the structure of the legs.

PIERIS SCHRANK.

Pieris Schrank, Faun. boica, II, 1: 132, 160
(1801).

Andropodum (pars) Hübner.

Ganoris Dalm., Kongl. vetensk. acad. handl.,

xxxvii: 61, 86 (1816).

Pontia Stephens et al.

(Not Pontia Fabr. restr.)

Type.—*Pap. rapae* Linn.

Tiny white butterflies ("Brides" children name them)
Flicker and glimmer, and turn in their flight
Surely the sunshine suffices to tame them,
Close to my hand they will swing and alight!

MARGARET DELAND.

. . . Fleecy, gauze-like, floating draperies,
Like drifted snow or sea-foam fantasies.

TAPPAN.—*Hesperia*.

Imago (56:6). Head moderately large, furnished with long delicate hairs of nearly equal length in front and above. Front tumid, particularly in the middle (where it is minutely tuberculate), considerably and rather generally surpassing the front of the eyes, above descending considerably to the antennal pits and continuing nearly on a level to the expanding termination behind the antennae where there is a delicate transverse ridge; the portion in front of the antennae is half as broad again as high and as broad as the eyes on a front view, the sides scarcely diverging; lower border squarely docked. Vertex somewhat depressed above, tumid behind, only in the latter part surpassing the level of the eye, the anterior outer angles raised somewhat and a very little produced; anterior border scarcely concave, scarcely raised, the slight ridge abrupt. Eyes rather large and full, naked. Antennae with the posterior base in advance of the middle of the summit, inserted in distinct, moderately deep pits, separated from each other by the width of the second antennal joint; considerably longer than the abdomen, composed of thirty-three or thirty-four joints of which the last seven or eight form a depressed subspatulate club about two and a half times broader than the stalk, three or four times longer than broad, increasing in size very gradually and slightly as far as the antepenultimate joint, the last two forming a bluntly rounded tip. Palpi slender, nearly half as long again as the eye, the terminal joint equalling the middle in length and double the length of the basal, all clothed thinly with scales and all but the apical furnished beneath with a rather thick fringe of very long, nearly equal hairs, compressed in a vertical plane.

Prothoracic lobes obsolete. Patagia very small, broad, with a slender lobe scarcely arching and depressed rather than tumid, composed of a very broadly longitudinally oval basal portion from which projects a tapering, very slender, posterior lobe, two-thirds as long as the basal portion and slightly hooked at the tip, the sides strongly hollowed at the base.

Fore wings (40:7) from two-thirds to more than three-fourths as long again as broad, the costal margin gently curved, almost straight in the middle, the apical angle almost rounded off; outer border nearly straight or very gently curved, below receding to meet the straight inner border, rounding off the angle. Costal nervure terminating considerably beyond the middle of the costal border; subcostal nervure with three superior branches, the first arising in the middle of the outer two-thirds of the cell, the second a little before the tip of the cell, the third as far beyond as the first is before the tip of the cell, branched somewhat before the middle, the upper branch minutely forked at the very tip; cell three-fifths the length of the wing and fully three and a half times longer than broad.

Hind wings with the costal border roundly shouldered at the base, beyond very nearly straight, outer border more or less prominent in the subcostal region, pretty strongly convex, more regularly so in the ♂ than in the ♀, which has the central portion a little less curved; outer lower angle very broadly and regularly rounded, the inner

margin expanded at base, beyond gently curved, continuous with the curve of the outer margin. Branch of costal nervure curved strongly outward beyond its middle; vein closing the cell striking the subcostal and median nervures at equal distances beyond their second divarication.

Androconia lyre-shaped, very broadly expanded at the base, with exceedingly large basal lobes, apically narrowing to a short, equal lamina which is apically angulate and heavily fringed.

Fore and middle tibiae of equal length; fore tarsi of the same length as the fore femora and the middle tarsi and not much shorter than the hind tarsi; hind femora two-thirds (δ) or a little more than half (γ) as long as the middle femora. Femora thinly fringed with rather long hairs. Tibiae very abundantly supplied on all sides with very small and slender spines, scarcely arranged in rows and at the tip with a pair of rather stout and moderately long spurs. First joint of tarsi rather more than equalling all the others together, the second, third and fourth diminishing very slightly in order, the fifth equal to the third; all are armed profusely with spines similar to those of the tibiae, irregularly distributed above and on the sides, below with four rows; on each joint an apical pair but slightly longer than the others; claws but little divaricate, small, slender, compressed, rather strongly curved, blind to the middle, the upper branch a little the longer and much less curved; paronychial as long as the claw, consisting of a broad, slightly narrowing lobe, with a bluntly rounded, scarcely pointed apex, concealing almost the whole of the claw on a side view; pulvillus rather large, obovate, on a rather long and stout peduncle.

Upper organ of male abdominal appendages large but slender, depressed, tapering, curving slightly, the hook and centrum of equal length, the lateral arms united to form a short and slender, tapering process, extended beneath the apical half of the hook and by bending downward, rather widely separated from it. Clasps flat, directed almost horizontally backward, half as long again as broad, the apex equal or scarcely tapering, the posterior border well rounded, a little bent in the middle.

Egg. Sugar-loaf shaped, more than twice as high as broad, largest above the base, tapering next the summit much more rapidly than before, terminating in a flattened top, the base squarely docked; a moderate number of sharply defined but not greatly elevated ribs run from the base to the summit, occasionally not quite reaching it, but sending, at their termination, oblique shoots to their neighbors; transverse lines regular, continuous, crossing the ribs, frequent, slightly raised. Micropyle rosette composed of a central circle, surrounded by four disconnected ovals, between and beyond which are large, roundish cells, followed by very large, transverse, semi-lunar cells.

Caterpillar at birth. Head broadest at summit, considerably broader than high, below very fully and pretty regularly rounded, furnished with a few rather long, very slender and tapering hairs; mandibles broad (86:32), with five unequal, blunt denticulations.

Body of the adult form, furnished with a longitudinal series of broad, mammiform elevations, each with a high, truncate, conical nipple, emitting a long and very slender hair, scarcely tapering, the apical portion delicately expanding into an oval club of more than twice the diameter of the hair just preceding it (86:44); they are arranged, one on a segment, in a laterodorsal, lateral and laterostigmatal series, the first and third placed anteriorly, the second also anteriorly on the thoracic segments, but posteriorly on the abdominal; the laterodorsal hairs of the first segment are much longer than the others, and terminate in a delicate point, tapering throughout; there is also in a substigmatal series two on a segment, the anterior larger and a little lower. Legs pretty long and slender, tapering regularly; claw small, slender, slightly curved, tapering; prolegs mammiform, the last joint short and slender; hooklets very slender.

Mature caterpillar. Head moderately small, very regularly rounded, front aspect very nearly circular, broadest in the middle, scarcely broader than high, the sutures distinctly but narrowly impressed, deepest next the ocellar region, not at all full in front, surface transversely rugulose, supplied pretty regularly but not very frequently

with small, slender, conical warts, bearing moderately long, curving, delicate hairs; triangle very large, scarcely higher than broad, but reaching fully three-fifths way up the front. Antennae with the first joint pretty large, mammiform, second very short, scarcely noticeable, third scarcely narrower than the second, a little swollen at the tip, half as long again as broad, the fourth exceedingly minute. Ocelli six in number, four placed in a slightly curving row, its convexity forward and slightly downward, directly behind a slightly impressed line, the upper three separated from each other by their own diameter, the fourth and lowest removed from the third by twice that distance, the fifth behind and a little above the first, and separated from it by a little less distance than the latter from the third; the sixth behind the second and equally distant from it and the fourth, with which it forms a little less than a right angle. The first four mentioned are prominent; all are of equal size. Labrum large and quite broad, the front angularly but not greatly excised in the middle. Mandibles short, very broad, not stout, the edge rounded, delicately dentate above, minutely denticulate below, the teeth triangular, not very long. Maxillary palpi with the joints equal in length, successively considerably smaller, the inner palp with very short and pretty stout joints. Spinneret short, tapering, rather slender, bluntly pointed.

Body cylindrical, largest in the middle, tapering very gently, uniformly and pretty equally toward either end, tapering behind to a bluntly rounded extremity. Segments divided faintly by transverse, impressed lines, into seven divisions, growing successively smaller toward the posterior end of the segment; on the thoracic segments a less number, usually five. Body covered with minute, cylindrical, hairless warts, scarcely tapering, abruptly docked, higher than broad, arranged pretty regularly in transverse rows, one row to each division of the segments; also furnished with abundant, irregularly scattered, very minute, tapering warts, giving rise each to a very short, and very delicate hair. Spiracles of moderate size, obovate, more than half as high again as long. Legs fleshy, large and plump at base, tapering rapidly, not very long, last two joints appressed pretty strongly; claw minute, slender, compressed, hooked at base, curving rather gently. Prolegs (86:31) large, pretty long, tapering pretty regularly but not very strongly, the hooklets arranged in a triple curving row, thirty-six in number, their exposed portion rather short and stout, compressed, tapering, bluntly pointed, rather strongly curved, those in the same row distant from each other by three or four times their diameter; outside the proleg, at the base of the pad, is a row of half a dozen similar hooklets. The glandular swelling on the under surface of the first thoracic segment (86:36) is larger than usual.

Chrysalis. The head is well rounded, the central prominence conical, bluntly pointed, moderately long and slender; the prothorax is slightly depressed and hollowed on either side, above its anterior border, with a pair of subdorsal, rounded, equal, forward directed tubercles, longer than broad, projecting over the extreme base of the antennae, the median ridge of the whole thorax strongly compressed, high, especially on the mesonotum, where it increases in height to the middle, and is there abruptly angulated at very nearly a right angle, the anterior slope to the base of the frontal tubercle a little concave, the posterior slope straight and only a little raised above the direction of the whole dorsal ridge. The lower surface, from the eyes to the tip of the wing, is very nearly straight, scarcely arched, the lower surface of the abdomen continuous with it; the sides of the wings straight and parallel, the basal wing tubercles prominent only by the narrowing of the body in front, and by broad, dull, inconspicuous ridges, which are directed downward and backward, and vaguely upward and inward. From the upper border of the eye a slight ridge runs backward in a straight course, through the basal wing tubercle, to the upper posterior portion of the wing, fading out before reaching it; first, second, and anterior half of third segment of the abdomen broadened and irregularly flattened above and furnished at the extreme lateral edge of the flattened part with a sharply angulated ridge, the outer half of which turns inward as well as downward, and which, curving a little downward on the posterior half of the third, and on the fourth segments, continues as a distinct, though rather slight, suprastigmatal ridge, to the lateral bases of the

cremaster; on the second, and especially on the third segment, the ridge is produced or elevated in the middle; a median carina, inconspicuous on the first three segments, but pretty high and rather strongly compressed on the succeeding segments, traverses the whole abdomen; the sides between this and the lateral ridges are sloped, scarcely arched; beneath the abdomen is well rounded transversely. Preanal button bounded laterally by pretty strongly curved, moderately broad, low, strongly punctate walls, terminating anteriorly in pretty large, equal, rounded, approximate, recumbent tubercles, half as long again as broad. Cremaster viewed from above, rather long and slender, tapering considerably, abruptly docked, half as long again as its medium breadth, deeply channelled above, the channelled portion expanding posteriorly; viewed from the side slender, increasing slightly toward tip, bent a little downward; the apical portion transversely curved, the convexity downward, slender, only the central portion of the field occupied by the hooklets, which crowd down the front and back, and form an irregular, rounded mass, broadest below. Hooklets distant, short, the stem rather stout, slightly curved, the apical portion greatly expanded and curved over so as to have a general direction at right angles to the stem, the extremity broadly rounded.

This genus is widely spread, extending over all the temperate regions of the northern hemisphere and even reappearing in South America beyond the tropics. In the Old World it spreads from ocean to ocean and from about the parallel of 30° to the polar regions; in America from about 35° N. Lat. to southern Labrador in the east and to the Arctic coast in the west; several species are found in either hemisphere, but none are common to both, with a single exception of recent importation; two species are found in New England.

The butterflies are white, sometimes tinged, especially beneath, with pale yellow; the markings are mostly confined to the upper surface of the fore wings, consisting of one or two dark spots a little beyond the middle of the lower half, and a dark edging to the apex and inner border; beneath, grayish fleckings often border the veins of the hind wings. The spring brood differs somewhat from the later ones in the heaviness of the markings and even in the length of the wings; and sulphur colored varieties of several of the species have been found, in northern localities at least.

The insects are always at least double brooded and pass the winter in the chrysalis; they are among the earliest butterflies, wintering as chrysalides, to appear in spring. The eggs are laid on the leaves of wild and cultivated Cruciferae, and are deposited in large numbers upon a single leaf, but are never clustered; the caterpillars live independently though very many of them may be found upon the same plant; they live in exposed positions, though generally on the under side of leaves, unless the plant forms a head, as cabbage, when they generally penetrate towards its heart in search of the tenderer leaves. They are thus more destructive to useful plants than the caterpillars of any other butterflies. The chrysalids are frequently found attached to palings and hang for from one to two weeks in summer. The butterflies have rather a weak, fluctuating, uncertain flight, very different from that of some of the neighboring genera,

and are familiar to everyone from their friendly habits and conspicuous color.

The eggs are sugar loaf shaped, fully twice as high as broad and furnished with prominent longitudinal ribs. The juvenile larvae are furnished with long, hair-like appendages, tapering slightly, but at the tip expanding into a delicate cup. The mature larvae are long, slender and cylindrical, tapering slightly at either end, the head appearing continuous with the body. Being almost exactly the same shade as the leaf upon which they feed they are readily overlooked, although the pale, stigmatal bands of some species render them a little more conspicuous. Among the hairs upon the surface are some mounted on more prominent papillae; these are hollow tubes through which a fluid is emitted at the infundibuliform tip, to support which the edge of the latter is furnished with a fringe of a few excessively fine hairs which enables a globule many times larger than the tip to be supported by it; the globule is under the control of the creature and one may see it enlarge under his eye; it attains a diameter of .075 mm., and the supporting hairs are of about the same length. They are voracious feeders and gorge themselves till they seem near bursting. The chrysalids have the sides of the body ridged and at the third abdominal segment elevated to a more or less distinct point; the middle of the thorax has a similar dorsal elevation and the rounded front of the head is produced anteriorly into a short, blunt tubercle; they are generally rather pale green or yellow flecked with black.

*EXCURSUS XLVI.—THE SPREAD OF A BUTTERFLY IN A
NEW REGION (WITH A MAP)*

Les papillons couleur de neige
Volent par essaims sur la mer;
Beaux papillons blancs, quand pourrai-je
Prendre le bleu chemin de l'air?

THÉOPHILE GAUTIER.—*Pantoum.*

DIFFERENT races of men have not always occupied the regions which they now inhabit, but from the earliest times one wave of migration has followed another in a manner that has proved very perplexing to the ethnologist attempting to follow them. That lower animals also have had their migrations has been frequently proved by the occurrence of their remains in regions where they are not now found. Secular change of climate has been the great moving cause of most of the migrations of which we have any knowledge, with the single exception of the influence of man, and particularly of civilized man; he is everywhere upsetting the arrangements of nature, directly or indirectly exterminating all forms which cannot endure his presence or withstand the baleful influences which follow in his train. To minister to his wants, for instance, he brings into a new region

a plant foreign to its soil that he may have the fruit ready to his hand. Without the natural hindrances which prevent its supremacy in its native home, it thrives so vigorously, if otherwise adapted to the place, as to supplant the natural denizens of the soil; these are supporting numerous animals, which in their turn suffer.

So it has doubtless been in all ages of the world, where by any of the multifarious means which nature employs she has herself upset the balance she had established, by bringing into a flora or a fauna some new element from without. Indeed, the history of animal and plant life has been a story of colonization. Any one who has observed the rapidity with which weeds spread over new countries, has read of the rabbit nuisance in Australia or seen the sparrow nuisance in America, will comprehend what a force colonization may have been. It was closely linked no doubt with the introduction of new types in past ages of the world.

The measurement of the spread of a newly introduced species has rarely been attempted. Indeed, in the nature of things it could scarcely ever be made except under circumstances which may fairly be deemed artificial, that is, in countries tolerably well settled with people intelligent enough to report accurately. Rarely, too, is the date of introduction known. Yet as this could be approximately determined for the European cabbage butterfly recently imported into this country, and as by its ravages of a common garden crop it would make itself known by the damage it did and so force itself upon observation, it was believed that the correct measure of its spread might have some import for future investigation, and perhaps its lesson for him who would designedly introduce a new creature without regard to its relations to other animals.

The butterfly, *Pieris rapae*, was first noticed in Canada, and the actual history of our knowledge of its first appearance there is as follows:—Mr. William Couper, a taxidermist and general collector, addicted especially to Lepidoptera and a good observer, living in Quebec, first captured a few specimens in 1860 in the immediate vicinity of that city; he then looked upon the insect as a great rarity, and indigenous to Canada.

In 1863 a new collector appeared in Quebec, Mr. G. J. Bowles, who, capturing it and finding no such insect described in American works, applied to Mr. Couper, only to discover him equally at a loss. Mr. Bowles then wrote to Mr. William Saunders of London, Ontario, and to myself, and we both assured him that it was the European insect. In April and July 1864, these gentlemen read papers before local societies, both of which were published in whole or in part, and from these we learn that in 1863 the butterfly was very common and destructive in the neighborhood of Quebec and at Laval fifteen miles north, and had extended thirty miles to the northwest along the north shore of the St. Lawrence, though they had not been noticed beyond Point Lévis on the south, nor taken at St.

Anne's on the south shore of the St. Lawrence seventy miles down the river "where a collector of Lepidoptera resided." From what we know of the rapidity with which a single pair may propagate without hindrance from parasites, we may conclude almost with certainty that it was introduced in the early part of 1860 or at the earliest at the very close of 1859. Owing, apparently, to Mr. Bowles' paper, published in the Canadian Naturalist in 1864, in which he fixes the period of its introduction to Quebec "at about seven or eight years ago," it has been generally spoken of as introduced "in 1856 or 1857." But Mr. Bowles has allowed more time than is necessary, and records do not go back of 1860.

Following the report of Mr. Couper of its distribution in 1863, we have at first but scanty information concerning its spread in Canada. Captain Gamble Geddes of Toronto states that he first took it "about 1864, about ninety miles below Quebec; when I brought it back and showed it to Professor Fowler, then connected with the Natural History Society of Montreal, he assured me that it was quite the first that had been taken." This fixes the date of capture as before the publication (in Montreal) of Mr. Bowles' paper and indicates that in 1864, the insect had spread to Murray Bay, on the north shore of the St. Lawrence.

In 1866 begins our first considerable knowledge of the spread of the butterfly, as it has reached more populous districts. Mr. William Saunders, on an excursion to the Saguenay, found it at Cacouna opposite and a little above the mouth of the river and at Ha Ha Bay at the head of steamboat navigation on the Saguenay, as well as all the way to Chicoutimi, twelve miles further up the river. It was not, however, found at Tadousac at the mouth of the Saguenay. We know by its subsequent record that it must have spread westward and especially southward by 1866, and it was indeed taken at Brome township within a dozen miles of the Vermont border by the Rev. T. W. Fyles. Dr. G. Dimmock speaks of it as found this year also in northern New Hampshire and Vermont, but without specification, and Dr. J. C. Merrill reports the capture of a single specimen in the White Mountains; that it must have invaded these two states this year is certain from the considerable numbers found the year following. I have accordingly drawn the curve of its distribution to include this northern area. Moreover, it is certain that it had reached this latitude in Maine, for there is a specimen in the Yale College Museum, which was taken by Professor S. I. Smith in Norway, Maine, in 1865, the earliest record of its capture in the United States. Probably it had covered the larger part of Maine wherever in the wilderness it could find a patch under cultivation, for writing from Garland in Penobscot Co., under date of Aug. 23, 1869, Mr. H. C. Preble says that he has "not been able to raise a respectable cabbage for some four or five years, on account of the ravages of this species of voracious rascals." Even if we

credit him with some exaggeration from discouragement, we can hardly think the insect arrived there later than 1866, the more probably as Professor Smith again helps us by preserving in the Yale Museum two specimens captured by him at Eastport, on July 4, 1866.

The following year, 1867, marks a better known advance, for in May it reached Montreal to the southwest, and extended on the southeast even to Halifax, Nova Scotia. In Maine it was observed at Lewiston far toward the southern extremity of the state, though resident entomologists elsewhere in the state did not discover it until the following year. Notwithstanding the number of entomologists who annually visit the White Mountains, and the recorded capture by Mr. Merrill in 1866, no one seems to have taken the insect in New Hampshire in 1867, though with its spread to Lewiston on one side and its appearance in considerable numbers in Vermont on the other, there can be little doubt that it was present at least in the region north of the White Mountains and especially in the valley of the upper Connecticut. In Vermont, Dr. Merrill found the butterflies at Waterbury, Burlington and Stowe; in the first locality, on August 29, they were "very abundant." During this year, therefore, the insect had fairly established itself in northern Vermont and New Hampshire, reached Montreal in its course up the St. Lawrence and pushed its advance guard to the Atlantic Ocean at Halifax and nearly to the Gulf of Maine at Portland.

In 1868, curious to say, our records are more meagre but in respect very interesting. It was only in this year and toward the end of it that it reached Waterville, Me., to judge from the fact that it was first seen in the early spring of 1869 by a very careful resident observer, the late Prof. C. G. Hamlin. The butterflies must have come from wintering chrysalids near by. In New Hampshire and Vermont its progress was steady but not extensive. In New Hampshire it was taken this year at Warner near the southern Kearsarge and was seen near Lake Winnepesaukee. In Vermont it had extended to corresponding points, for it was common at Woodstock and not uncommon in August in Sudbury, while in all the track behind it was abundant enough. Writing to me from St. Albans in 1869, Mr. N. C. Greene said that in the previous autumn his 3000 cabbages had from ten to fifty worms on a head; he had not previously noticed the butterflies at all and thought they first came in 1868, whereas they must have reached St. Albans early the year before that. In the valley of the St. Lawrence there is nothing, for a time, to gauge its movements, but in September, 1869, Mr. Ritchie says that he has heard of its ravages as far west as Chateauguay, so that it doubtless was to be found there in 1868. Nor can we say more concerning its extension into the eastern provinces, though I am told by Mr. G. F. Matthew that it appeared at St. Johns "within two or three years of its recorded advent at Quebec" and,

therefore, certainly not later than 1868. Indeed we have seen that it was just on their border, at Eastport, in 1866, and Prof. L. W. Bailey, writing in 1886, says it has been at Fredericton "for at least twenty-five years," but he speaks only from recollection.

But the chief interest of the year 1868 lies in the fact that it was then independently introduced into the country at New York. Rumor has it that a German entomologist in Hoboken received some living pupae from Europe to raise for his cabinet, that they emerged from the chrysalis in his absence and afterward escaped from an open window. But however this may be, we know from several sources that it was to be found about Hoboken and Hudson City, N. J., this year. Mr. John Hampson, a collector of twenty-six years experience, living in Newark, took a single specimen there this year in May. The late Mr. W. V. Andrews, sending me caterpillars in July, 1869, said it had "been known for a year or two," and the same writer says in January, 1870, "the increase of this insect during the last two years is marvellous." Indeed its abundance the next year at Bergen Hill, West Hoboken and Hudson City is proof that the first specimens came to the spot in 1868. The fact that New York City does not draw upon the Lake Champlain region for its cabbages and the subsequent evident spread of *Pieris rapae* from two points prove this to have been in all probability an independent introduction into the country. It is only surprising that it was so long delayed.

The spread of the butterfly from this new centre during 1869 does not appear to have been very great. That in scanty numbers it followed the track of the railway toward Philadelphia is probable from the nature of things and from the fact that Mr. J. P. R. Carney took a specimen that year within the present limits of Camden, which he at the time supposed came across the ocean in a vessel, then unloading near by; yet Mr. Andrews wrote under date of August 26th in that year that while "quite abundant in the neighborhood of Bergen Hill and Hudson City, ten miles hence I could not find a single specimen." It reached West Farms in the autumn of that year, where it was seen by Mr. James Angus, but not taken; specimens were, however, taken the following April fresh from the pupa. It was also reported as very common in 1869, in the parks and gardens of New York city, by several observers, though Mr. T. L. Mead, an enthusiastic lepidopterist at the time and a resident of the city, records the capture of a single specimen on the Jersey side of the Hudson River as if its presence in the metropolis were quite unknown to him. It seems probable, therefore, that its occurrence in the vicinity of New York was taken for its presence in the city itself. Still it may well have been present in spots not visited by Mr. Mead and I myself found it swarming about parks in the heart of the city in June, 1870. I can find no record of its appearance this year in Long Island. In 1869, then, with the exception of a straggler

toward Philadelphia the butterfly is not known to have spread more than ten or fifteen miles in any direction from New York.

The northern horde of invaders in the meantime was steadily pushing southward; how far to the west is quite unknown, for there are no reports for 1869 from the St. Lawrence valley, except the one above referred to, of its ravages at Chateaugay. So, too, from Vermont and New Hampshire, the only accounts are of its great abundance in the northern portions and its appearance in every quarter, these including the alpine regions of the White Mountains. In Maine, however, it had everywhere reached the seacoast and was found in numbers in all the inhabited portions. It was abundant at Bangor and reported from Norway, Mt. Desert Island at the end of July, Eastport and Portland. It was indeed along the seacoast that it pushed its way southward most rapidly, for in the spring of this year it reached Boston. I saw my first specimen on July 17, on Boston Common, but other observers were ahead of me. Mr. P. S. Sprague, for instance, saw it in the same spot April 26, and Mr. F. A. Clapp on May 20; by the autumn they were not very uncommon. A single specimen was also said to have been seen this year near Worcester, but this is rendered exceedingly doubtful by subsequent reports. Probably the nearest point at which the northern horde approached the southern was somewhere on the Hudson or Connecticut Rivers not far above the latitude of 43° N.

For although, as we have seen, it was abundant at Sudbury in August, 1868, it was not until the spring of 1870, to which year we now turn with some curiosity, that it was recognized in the centre of eastern New York, where two such entomologists lived as Dr. Asa Fitch and Mr. J. A. Lintner. East Greenwich where Dr. Fitch resided is almost halfway from Albany, Mr. Lintner's home, to Sudbury, Vt., yet in both these New York localities it appeared for the first recognized time in 1870, and then not until midsummer. Under date of March 16, 1872, Mr. J. A. Lintner writes me in detail regarding its appearance this year: "I observed it here [Albany] for the first time on July 24. Dr. Fitch reports it at his residence in East Greenwich, Washington Co., thirty-two miles in a direct line E. of N. from Albany, on the 2d of August. On August 6, I saw it quite numerous at Saratoga Springs, thirty miles north, and on the 8th at Glen, Warren Co., sixty-five miles W. of N. of Albany. During the month of July a large number of the butterflies were seen at Crown Point and Westport on Lake Champlain, and at the latter place [a short distance northwest of Sudbury, Vt.] the garden cabbages were so utterly ruined by the larvae that they were pulled up and fed to cattle; . . . September 11, I observed it abundantly at Utica, Oneida Co., ninety-five miles west by rail. October 8, I saw larvae but no butterflies at Cherry Valley, Otsego Co., fifty miles westerly. The latter part of July it was seen at Sharon Springs, forty-five miles west; while at

Schoharie, an intermediate point thirty miles west, I did not detect it until perhaps two weeks later." As it is not reported from the eastern end of Lake Ontario for a year or two, the butterfly probably reached Utica by the eastern side of the Adirondack region, to do which it must have spread more rapidly in a western than in a southern direction from the southern end of Lake Champlain. Moreover, Mr. Hawkins tells me that it appeared this same year in Oneonta, Otsego Co., considerably to the south and east of Utica. Along the Hudson, Mr. Lintner does not report it as extending farther south than Bath, five miles below Albany, in September. There can be no doubt that it had this year completely overrun Vermont and New Hampshire, though the only records I have in the southern portions are that the first specimens were taken by Mr. C. P. Whitney at Milford, N. H., on May 26 of this year, that it was abundant there by autumn, and taken in numbers at Walpole, N. H., in June. But it had followed down the Connecticut valley much farther than this, for it was taken at Holyoke, Mass., by Mr. J. E. Chase; and Dr. George Dimmock reports that the first specimen was taken near Springfield in the early part of May on the Longmeadow road; that it was abundant before autumn and that in July he took it in considerable numbers as far south as New Britain, Conn. The first noticed by Mr. E. Norton at Farmington, Conn., were also seen this year but "not often"; in the following year it was quite common. It also became common this year at Walpole, Mass., seventeen miles southwest of Boston. It would appear therefore that, at the close of 1870, the southern limits of the northern host were at about the parallel of $42^{\circ} 19' - 30'$, with a considerable extension down the Connecticut valley.

Meanwhile the southern horde was extending its outposts. The entire extent of Long Island was occupied this year, for Prof. S. I. Smith found the butterfly very common at Fire Island Beach in August and Mr. B. H. Foster reports destruction at Babylon. In further direction toward the northern band, Dr. Dimmock found "a few" at Bridgeport, Conn., in July, which may have belonged to the other group, but far more probably were the descendants of those that occupied West Farms the year before. Dr. S. Lockwood tells me that it invaded Monmouth Co., N. Jersey, in 1870 and in October of this same year the editor of the American Entomologist saw it around fruit stands in Philadelphia; Mr. W. D. Doan writes that it appeared in scanty numbers this year at Atglen, Chester Co., Penn., and Mr. Townsend Glover says that it appeared even as far as Baltimore "anterior to 1870"; but this I think must be an error of memory. It appears, then, that the southern horde did not this year quite reach the northern, but the two approached each other so nearly as inevitably to mingle in 1871; and that the northern had almost everywhere reached the eastern seashore of New England and the Canadian provinces, and on the

west had extended probably to Lake Ontario and nearly to central New York. The southern, on the other hand, had covered Long Island eastwardly, and was pushing its way also along the northern shore of the Sound, while its main army was directed southward, had covered New Jersey, and extended into eastern Pennsylvania.

In the next year, these two armies, having devastated the country with independent forces for fully three years, met and mingled, and then swept westward and southward with increasing rapidity. They covered all the ground which lay between the outposts of the previous year, this being the year in which it was first seen in Rhode Island, at Providence, and at Hunter, N. Y. It also extended to some of the higher regions previously untouched but swept past, such as Williamstown, Mass., and became, as usual, excessively common where it had only appeared scantily the year before. There were even some spots not invaded until 1872, and it would appear that the advance guard, which swept down the rivers flowing southerly and along the seacoast, left the inland districts long untouched. Thus it is reported as not seen in Stowe, Mass., at the close of 1871. Mr. Dickinson showed to the Natural history association of Worcester in 1872 several specimens that had been found in a garden there, as if they were of special interest as new comers (so that the rumor that one was taken there in 1869 must be an error), and it is thought not to have appeared in Sherborn until 1872. By that time it had probably overrun every nook and corner of New England. Similar irregularities appear in all its subsequent movements westward.

Of its westward movement in 1871, we still have no information from northern New York or north of the boundary, and can only judge by subsequent notices that it must have reached at least the extreme eastern end of Lake Ontario. It had certainly passed the centre of New York, being found common at Ithaca this year, where indeed it made its first appearance the preceeding year according to Mr. Howard, though Mr. A. C. Weeks thinks it did not occur in Tompkins Co. in 1870. It was "troublesome" this year or 1872 at Cazenovia, while Mr. Saunders states that "by 1871 it had travelled . . . west to the middle of the state of New York." In Pennsylvania it is reported as harmful this year in Luzerne Co., and as present at Easton and Lancaster; this does not greatly increase its western range. But it had pushed somewhat further southward, following the coast line; injury was done to crops in Cecil Co., Md., during this year, and it appeared in Baltimore. Writing me from Spottsville, Va., Mr. B. W. Jones says "It was a general complaint (in Surry Co.) as early as 1870-71 among farmers, that they could raise no good cabbage on account of it. In 1872-73 it infested the gardens about Petersburg in untold numbers." Yet it was not seen in Washington until 1872. This year then is remarkable for the union of the two armies and the considerable western extension in New York.

In 1872 we again are able to trace the forward movement of the butterfly in Canada, where it originated, and from which information entirely fails from 1867, when it reached Montreal, until this time. For now we learn that it had passed by this time along the northern shore of the St. Lawrence and Lake Ontario to Belleville and Trenton, Ontario. But south of the river and the lake it had pushed much farther, viz., through the entire length of the state of New York, so as to invade Canada from the United States! It did not reach Port Hope, Ontario, from the east, where Mr. Bethune was awaiting it ("we fully expect to see it at Port Hope this year,") until July, 1873, but it appeared at Ridgeway, Welland Co., "not in great numbers" in 1872, and at Toronto in August, 1872. This makes it highly probable that it reached Buffalo this year, of which I could not otherwise speak, as the testimony of my correspondents is widely conflicting. Certainly it reached Brockport, for it was taken there in September by Mr. David Bruce, and the next year had certainly spread much farther west on the southern than on the northern shores of Lake Erie. It was in this year that it reached Delhi. In Pennsylvania, though it probably reached Centre Co. in this year, it was possibly checked in its westward spread by the Alleghenies, as we do not hear of it in the western part of the state. It reached Washington early in this year, but how much farther south it passed we do not know. As, however, we have already heard of it in Virginia, it is probable that it had extended southward at something like its previous rate and we have accordingly drawn our curve to correspond with this.

In 1873, as before stated, it reached Port Hope, and "F. C. L." reports taking his first specimen at Dunn in Haldimand Co., Ont.; some were also taken at Hamilton, where one would have looked for it the preceding year from its presence then at Toronto. Mr. Moffat indeed thinks it highly probable that it was there in the autumn of 1872, since white butterflies (which without special notice he took for protodice) were then swarming everywhere about flowers. This year it had entirely covered New York state, though there were places even in the eastern half, such as Norwich, where it did not appear until this year, at least in any number. It was found sparingly at Cleveland in the spring of this year, but from here southward our information is practically a blank. We have, however, two curious items: it is reported by Mr. C. R. Dodge as being destroyed by parasites in Louisville, Ky., in this year, which implies that it appeared there at least the year before (probably Mr. Dodge's informant mistook the destructive southern cabbage butterfly for this).

The other is a very definite piece of information from Prof. L. R. Gibbes of Charleston, who, in a recent letter to me, after mentioning the year 1870 as one which was remarkable for the number of Lepidoptera seen in that city, says that *P. rapae* (of which he possessed English exam-

ples in his cabinet) was not to be found, but "in 1873 I observed it as not uncommon in this city, and recognized it at once, while flying, as distinct from its congeners *P. monuste* and *P. protodice*; . . . I have seen it I think every year since." This appears to be an unquestionable independent introduction of the species from a coasting vessel, and it is due to this probably that we find it invading the southern Atlantic states sooner than we should otherwise anticipate. In the curves, therefore, I have given this new southern horde a distinct claim to local independence, and brought the northern curve to the ocean at a comparatively high latitude.

In 1874 we again hear of the insect to the east of its point of origin, N. Corneau reporting it as rare at Godbout river on the lower St. Lawrence, the northeasternmost point from which it has yet been recorded; its progress westward in Canada seems to have been very slow. It was abundant now at Hamilton but it did not reach Paris this year or certainly not until the very end of the year. It had become noticeable at Cleveland by its ravages during this summer as well as in western Pennsylvania. It made its appearance among the mountain valleys of West Virginia in September where it became abundant the following spring. It was "by no means rare" in Virginia.

Of the extension of the southern horde we know nothing, but from the record of later dates I have assumed an enlarged curve which seems best to agree with the facts.

But here enters a new factor. Dr. A. W. Chapman, a well known and experienced lepidopterist, writes from Apalachicola, Florida, that the butterfly first appeared there in 1873 or 1874; adding that it has not yet become common, only half a dozen being seen in a season. Here we have a second southern coastal introduction, unless indeed it was imported from Charleston by rail direct, as seems more probable. Its appearance, however it came about, at these two southern stations at such an early period explains why when the insect does not flourish so well in the extreme south as farther north* it managed to reach Alabama at least as soon as it obtained a foothold beyond the Mississippi.

Turning now to the year 1875 and beginning as before at the north, we find that it reached Paris, Ont., in the spring of 1875, and London in August. Saunders also tells us that it had reached western Ohio, and a gardener in southwestern Ohio reports that it first troubled him in 1876 at Mt. Repose, Clermont Co., and therefore presumably reached that place by 1875. It did not, however, reach Cincinnati until the following year though it had followed the western Alleghanies down to Maryville, Blount Co., eastern Tennessee, a little south of Knoxville, where Mr. E. M. Aaron saw it in 1875. It was now common in West Virginia, and presumably ex-

*In evidence of this, the fact that after fifteen years it is still scarce at Apalachicola is supported by its failure to invade the peninsula of Florida.

tended into North Carolina, though we have no report from there until 1878, when Mr. W. V. Andrews found it in March at Asheville. The southern part of our line for this year is, therefore, purely conjectural, as are also the lines for the southern colonies, from which we have no data.

There enters now a good deal of confusion in the dates of its appearance. The insect had become abundant on all the main railway lines running east and west and was liable to be forcibly carried in any direction. Wherever a pair, male and female, happened after all vicissitudes to come together, there would be the point for the introduction of a new colony; for mignonette or cabbage or turnip would be found somewhere about; and the only wonder is that the movement of the throng was as regular as it was.

During 1876 it covered the whole of western Ontario and extended into eastern Michigan; Mr. E. A. Strong even states that he took it at Grand Rapids in 1875, but this I think must be a fault of recollection. Below the Lakes, however, it moved on more rapidly. It is possible, if not probable, that one of the roadside colonies to which I alluded above was established in central Indiana before this, for Mr. S. G. Evans says that *Pieris rapae* was common in Evansville when he began collecting there in 1874; and Dr. G. M. Levette writes from Indianapolis, "From recollections of myself and others I would place it [the introduction at that point] in 1872 or 1873." We have the very definite statement from Dr. F. W. Goding that he captured a female in his father's garden in Kane Co., Ill., 44 miles west of Chicago, on September 17, 1875. A few days afterward, as he now distinctly remembers, he saw several in cabbage fields west of Chicago, flying in company with protodice. Mr. J. W. Huett also writes that he first saw the butterfly at Farm Ridge, LaSalle Co., in the spring of 1874 or 1875, in scanty numbers. It would therefore appear highly probable that, a year or two in advance of its normal rate of progress, as if it had caught the fever of its surroundings, *Pieris rapae* swept into Chicago on a railway train. We have no further record for this year of the advance of the great horde, but simply from analogy and subsequent facts, the curve of its probable progress has been placed on the map.

In this year, however, we have indications of the spread of both of the southern colonies, for in October Dr. A. Oemler detected the butterfly at Wilmington Island, off Savannah,—evidently an extension of the Charleston colony of 1873; while the fact that the butterfly was as common in 1876 as now, at Lumpkin in the southwestern part of the state, indicates the spread of the Apalachicola colony.

In 1877, to begin now with the south, these two southern colonies probably merged, for the butterfly was common at Macon, a point which probably might have been reached by either colony this year, though not by the northern horde for a year or two later, to judge by all accounts.

For, to forestall the succeeding years a little, the pest was not noticed in northern Alabama until 1879, nor at Atlanta, Georgia, until 1880, nor at Chester, S. C., until 1881.

From these points to Illinois is a long leap, but for this year it has no record. Excepting for the notice of its common occurrence at the head of Lake Rosseau in the Muskoka District, east of Georgian Bay, Canada, the only remaining data are for Illinois and Michigan; the butterfly had covered the lower half of the lower peninsula of Michigan and part of Illinois. The specific points which it had reached in the latter state are the region about Chicago—Maplewood, DeKalb Co., sixty miles west of Chicago, Decatur and Champaign, in the autumn. The first two of these may easily have been the mere extension of the Chicago colony, the two latter of the Indiana, but, in all probability, the succeeding year saw a blending of all the colonies, both north and south.

For then, 1878, not only is almost the whole of Illinois invaded, but the advance guard has pushed across the Mississippi and intrenched itself in Iowa and Missouri. It appeared at Carbondale early in the year, and "in injurious numbers" at Springfield. It had crossed the Mississippi at least two points. Prof. R. R. Rowley writes from Carryville, Pike Co., Mo., that he collected two specimens on radish blossoms at Louisiana in that county in July, 1878, and Prof. S. M. Tracy says that he noticed it at Columbia, in 1877, the first year of his residence there.* Further, Mr. J. M. Myers writes that five or six specimens were taken at Fort Madison, Iowa, in the autumn of 1878. There can therefore be little doubt that it was in this year that it first crossed the Mississippi. In Tennessee, too, it was close to the Mississippi in 1878, for it appeared this year at Ralston Station in Weakley Co.; and it was in March recorded from Asheville., N. C.

In 1879 it had extended up the peninsula of Michigan, having been taken at Ludington either this year or the preceding, and had invaded Wisconsin, appearing in May about Racine, and being abundant there, although it did not reach Milwaukee that year. In Iowa it made rapid advances. We have already seen it at Fort Madison in the southeastern corner. It probably appeared in 1878 also at Keota in Keokuk Co., for it was destructive there before the end of 1879. At Muscatine, it appeared in the latter part of May, and became destructive that year. It appeared this year also in Linn Co., where it was very destructive. But it went beyond the eastern tier of counties, for it was found at Des Moines, in the autumn at Ames, and had even advanced by midsummer to Omaha in Nebraska, that is, across the entire state of Iowa; in all probability it may have been prematurely carried to that great railway centre by the freight trains. The surprising thing about this is that it appeared to have no out-

*This is certainly possible, but it was more probably in 1878, to judge by other reports.

come, as we shall see. The butterfly appeared also about St. Louis this year and at many localities in Alabama, such as Marion and Selma, though Mr. Riley did not see it at Mobile on a visit there.

In 1880 it had advanced in the north, according to Mr. Saunders, to Manitoulin Island, near the northeastern end of Lake Huron, to the Sault Ste. Marie, to Rochester in the southeastern corner of Minnesota, to West Point, Nebraska, to Lawrence, Kansas, in March and to Manhattan in the same state. Dr. W. S. Newlon writes that it appeared at Oswego in the southeastern corner of the state on June 10, 1879, but he is not quite positive about the year. It is also reported this year from Atlanta, Ga., in July. It must have been there the year previous.

In 1881 we have few reports of its extension, but it was this year that it became common on Keweenaw Point, at Calumet, Mich., though the postmaster at Kasson says that it did not appear in that place until a year or two later. It was as late as August 3 that Mr. G. M. Dodge first saw it at Glencoe, Dodge Co., Nebraska, not fifty miles from Omaha and at about the same time his brother, C. F. Dodge, found Fremont "overrun" with them. Not until this year did it make its appearance at Salina, Kan., becoming common in 1882. It is also reported as appearing in 1881 at Bastrop, Texas.

In 1882, according to E. A. Dodge, it was already very abundant at Central City, Merriek Co., in the middle of the eastern half of Nebraska.

In 1883 we have several very interesting extensions. Mr. Walter Haydon, returning to England from Moose Factory at the extreme southern end of Hudson Bay, took with him an interesting collection of insects, among which Mr. J. Jenner Weir found a single pair of *P. rapae*, which were all he had taken there in a residence of five and a half years. Presumably the insect had arrived shortly before his departure. It was only in this year, that it appeared at Minneapolis, Minn., yet it was now that Capt. Gamble Geddes took it in Manitoba along the line of the Canadian Pacific Railway, at least as far as Brandon, about longitude 100°. Further, Mr. Charles S. Brown of Ludden, Dickey Co., Dakota, writes that he reached that country in 1883—one of the first settlers there—and noticed then a few specimens of the butterfly which has since become common. It is evident that it has nearly outrun the tide of civilization.

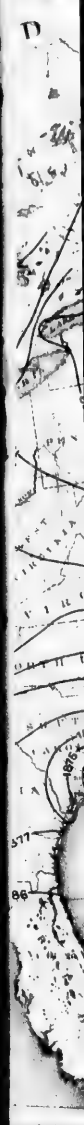
But even this record is outstripped by the report that it actually reached the Rocky mountains in Montana in 1884. Two correspondents have answered my inquiries from there; one has not seen it and says it must be rare or local if there at all; he has occasionally noticed a *Pieris*, but took it to be *P. oleracea*; the other says he saw none in 1883, one in 1884 and another in 1886. North of the boundary the insect has not yet reached Regina.

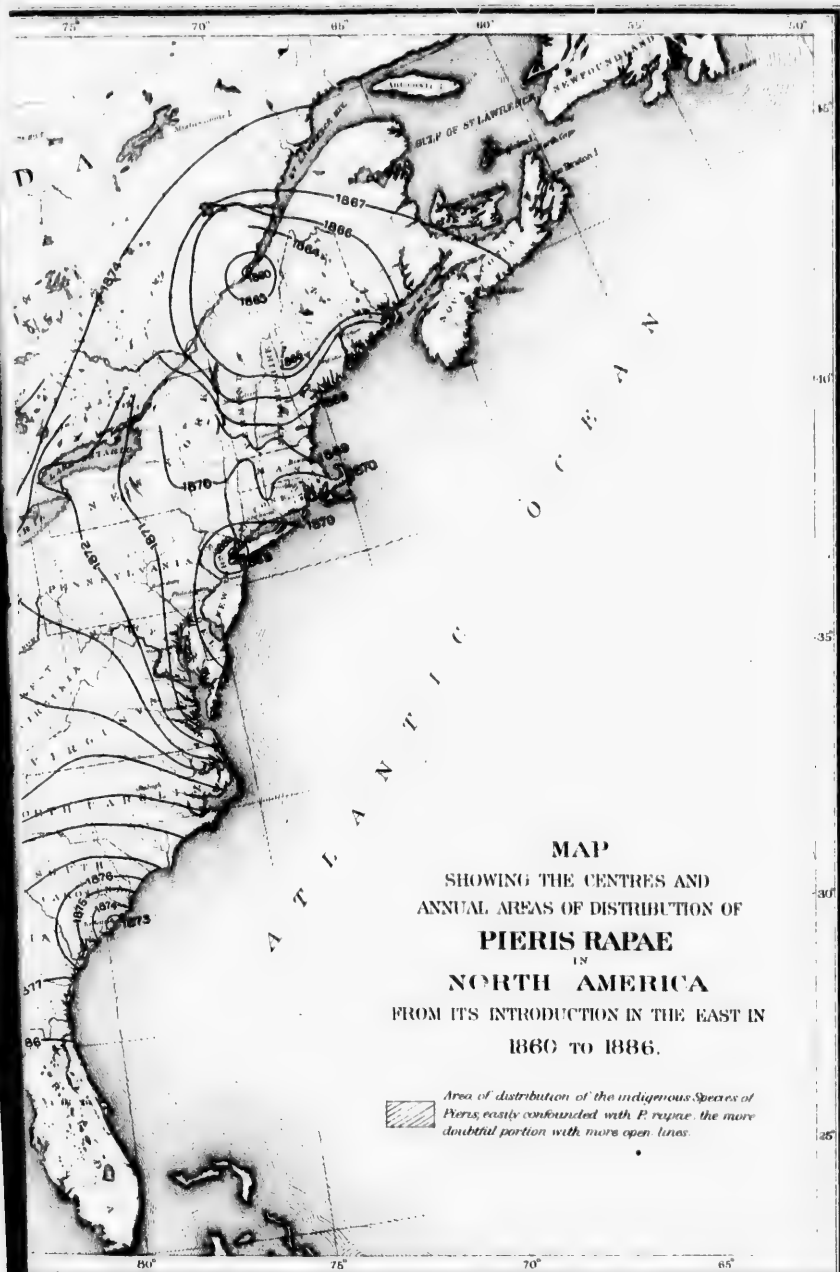
A few words only will suffice for all later statistics. In 1885 it is

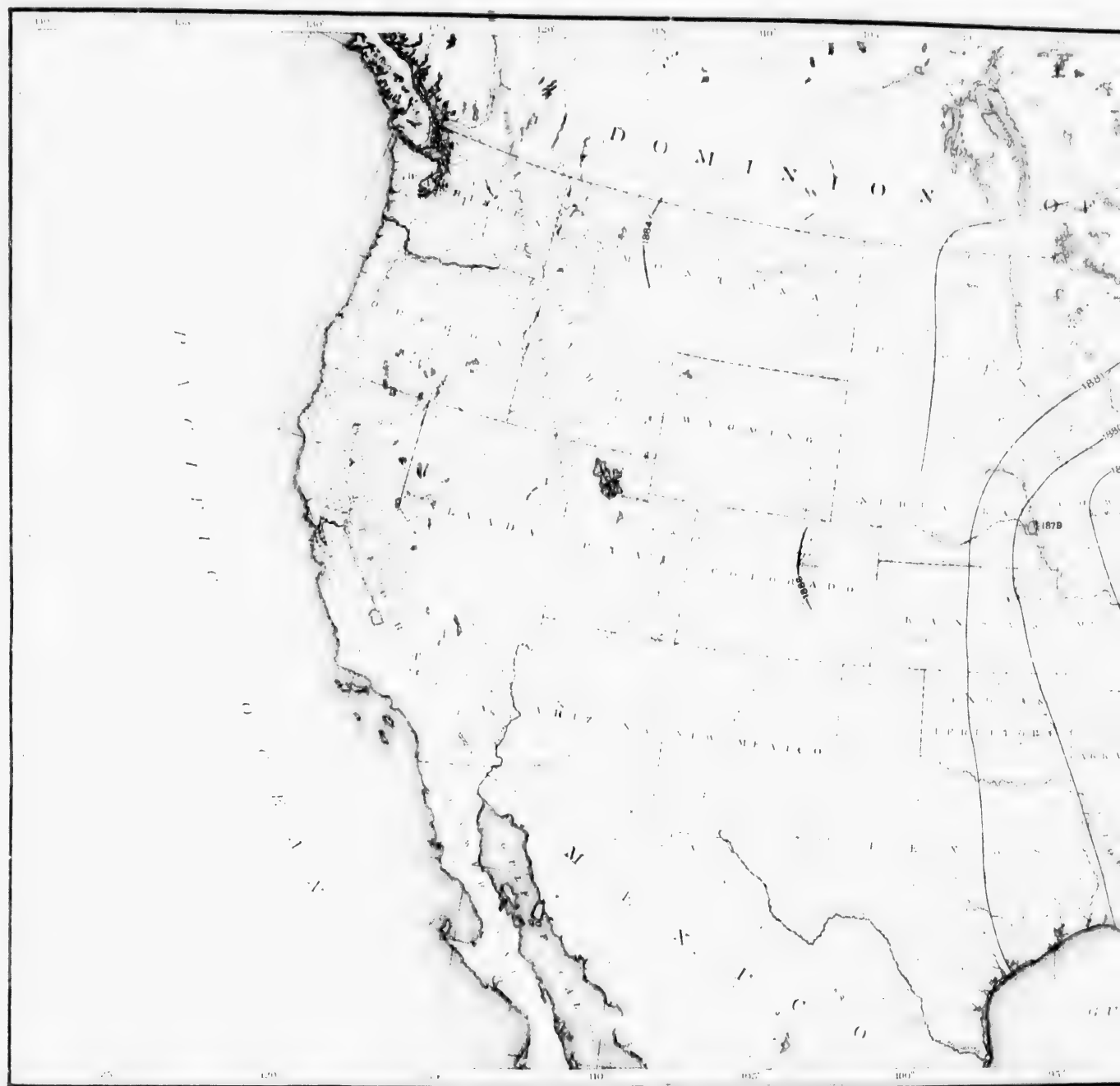
recorded from Duluth, at the western end of Lake Superior; and Mr. David Bruce, who spent three consecutive summers in Colorado and has closely watched all white butterflies on the search for some of the rarer forms, met with *P. rapae* for the first time in 1886, seeing a dozen specimens about Denver between August and October. In this same year it apparently made its first advent into the eastern half of Florida. Enquiries of several entomologists residing there, Messrs. Ashmead at Jacksonville, Hubbard at Crescent City, Mead and Chase in Orange Co., elicited the uniform response that the butterfly had not reached there; but Dr. J. M. Wheaton of Columbus, Ohio, writes that he obtained a single battered specimen about the first of April, 1886, while on a visit to Jacksonville. There is probably, therefore, no state in the Union, east of the Rocky Mountains, where it does not occur, though it has not been reported, to my knowledge, from Mississippi, Louisiana or Arkansas. It is hardly possible that it has not covered nearly or quite the whole of each, though Mr. R. d'Ailly of Malvern, Arkansas, writes that it has not yet reached that place in the centre of the state.

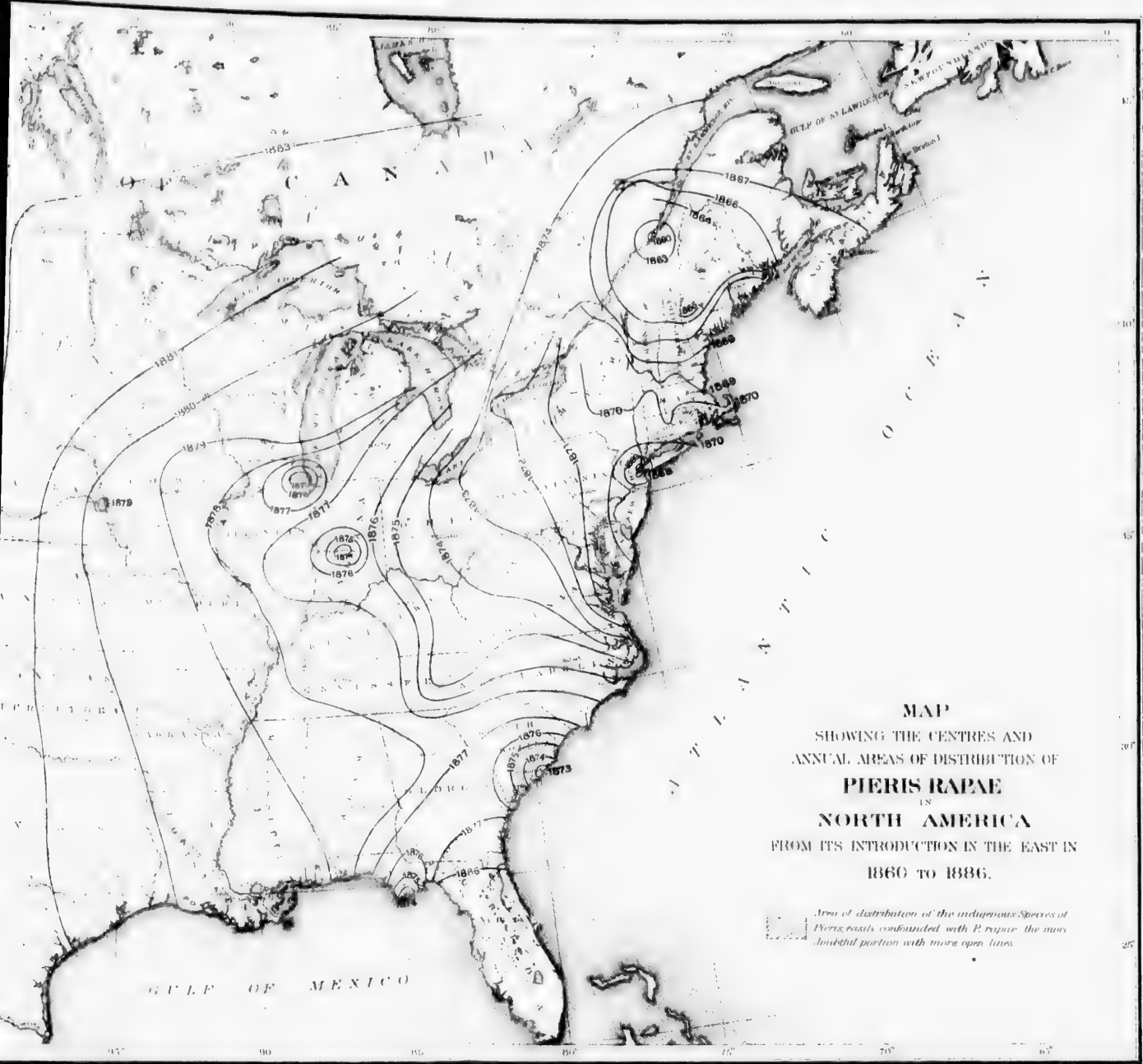
If now we examine the map upon which these statements have been represented, we shall be struck, I think, by two or three principal points: 1. The more rapid spread of the butterfly, at first, toward the east and southeast until it reached the sea, rather than toward the southwest along the valley of the St. Lawrence. 2. The comparatively small amount of hindrance mountainous and elevated countries seem to have presented in the early part of its career. Indeed, if the first record of its appearance in East Tennessee is correct (and we have excellent authority for it) these would seem in the warmer latitudes to have offered a distinct highway for the movements of the army, which the curves for 1874-1877 are meant to show. 3. The favorable influence of colonies on the spread of the pest, with the single exception of that at Omaha. 4. The excessively rapid, forward movement toward the west and southwest as soon as the Valley of the Mississippi is reached; compare, for instance, the five years' advance from Cincinnati, Ohio, to Lawrence, Kansas, or to Bastrop, Texas, and the otherwise rapid five years from central New York to western Ohio, or to the five years it took to cover the New England states. 5. The natural limit to its southern extension, as shown by the fact that it can hardly maintain itself at Apalachicola and has not pushed its way into the peninsula of Florida beyond, hardly to, Jacksonville, although it has for ten years been within what would elsewhere be not more than a year's flight away.

No mention has hitherto been made of the opinion of some entomologists, that *Pieris rapae* is indigenous to the Pacific coast of America, or at least has been known there for fully a quarter of a century and no one









knows how much longer. Specimens were first brought east by Mr. A. Agassiz in 1859. It is well known that the butterflies (not to mention other animals) of the Pacific coast are more nearly allied to those of the Old World than are the butterflies east of the Rocky Mountains; and therefore to one regarding these western Pierids as identical with *P. rapae* they may well be looked upon as autochthonous, inasmuch as in the Old World *P. rapae* extends from the Atlantic to the Pacific, from Great Britain and Barbary to Kamtschatka and Japan.

My own belief, however, is that we have in America, in addition to the introduced *P. rapae*, two distinct autochthonous species, each of which shows seasonal dimorphism similar to that of *P. rapae* and at least one of them some marked geographical races. If *P. rapae* and *P. napi* are distinct species, as they are universally considered in Europe, then the American species, previous to the introduction of *P. rapae* into eastern Canada, were distinct from the European and from each other. That certain forms of each of them, and especially of the western *P. venosa*, might readily be taken (as has been done) for *P. rapae* is unquestionable, and it is possible that the species seen in 1884 and again in 1886 at Great Falls and the Belt Mountains, Montana, was *P. venosa*, so marked. I have accordingly covered the area upon the map over which *P. venosa* is known to extend with close cross ruling, and that which it may probably also occupy with more open ruling. It will thereby be seen that the introduced *P. rapae* is rapidly progressing toward its near of kin. It may well be believed that if *P. rapae* has in the last five years crossed the high plains of Kansas and Nebraska on its westward march, as it has done, the butterfly considered by others as *Pieris rapae*, which has been on the Pacific coast since 1859 would, in more than a quarter of a century, if it were *P. rapae*, certainly have extended eastward across the less arid country along the northern boundary of the United States to a proportionably longer distance,—which it certainly has not done. It therefore fails in one characteristic of that ravenous and destructive species. It should be added that the only forms considered by any one as identical with *P. rapae* are those described by myself as *P. marginalis* and by Mr. Reakirt as *P. yreka*. They came from California, Oregon and Washington Territory.

With regard to the nature of the documentary evidence upon which this account is largely based a few words may be said. One would expect that much might be learned from agricultural and horticultural journals about the movements of the butterfly, but a great amount of time has here been wasted in vain search; very little was to be found and that little generally so vaguely stated as to be valueless. Direct enquiry has been almost the sole resource of value after the entomological journals, and especially the pages of the Canadian Entomologist.

In the mass of information received from very various quarters in reply to

a circular of inquiry I addressed to many persons, it has of course been impossible to weigh the evidence for exactly what it was worth. Some of it, as was to be expected, had to be thrown out altogether as coming from those who were not sufficiently observant to have distinguished between the new pest and its allies, also destructive to cabbages. To adopt indiscriminately all the data offered would have led to a chaotic result; we should have been obliged, for instance, to say that the butterfly appeared in Ohio in 1865, when it had only that year crossed the northern border of New England; or that it reached central Illinois in 1871 or 1872, or even in 1859, when it had not yet been borne across the ocean; or that it appeared in Georgia in 1862 and was abundant there in 1866, some ten years before its time. More possibly correct is the nearly accordant testimony of no less than three reporters, whose judgment I have no means of testing; they agree in giving 1864 or 1865 as the date of the first appearance of the butterfly in eastern Pennsylvania, and a fourth refers to it hesitatingly, perhaps as a matter of report: it is possible that it might have been brought across the ocean direct to Philadelphia at that date, but that it did not attract the attention of other entomologists in and about Philadelphia, or make its impression on the country around, renders the supposition highly improbable; nor do the facts given above, regarding its spread about New York, lead us to admit that it reached that city from Philadelphia. It is far easier to suppose either that a mistake was made by each observer in the species concerned, or that the memory was at fault,—all these statements coming to me in answer to my direct enquiries; none of them are printed records.

In conclusion, it may be remarked that the definite setting down of territorial limits to each year's spread will naturally raise the question in the mind of every lepidopterist who examines the map, whether it rightly interprets the matter for the ground with which he is familiar. I beg, therefore, to ask those who see reason to question the accuracy of the lines at any point kindly to give me the benefit of their better knowledge, by exact and detailed statements, and, where possible, founded on something better than memory. Should a sufficient number of important divergences come to light, I will make them public in a formal statement. It may be stated, in a general way, that the lines are more conjectural in the southern states than elsewhere, owing to the paucity of observations.

* See my paper (Mem. Bost. soc. nat. hist., iv, No. 3) for full authorities for the statements given above, principally derived from a large correspondence.

Table of species of Pteris, based on the egg.

Tapering distinctly above over the entire upper half.....	oleracea.
Tapering distinctly above only on the upper third.....	rapae.

Table of species, based on the caterpillar at birth.

Apically enlarged hairs less than one-third as long as breadth of head.....**oleracea.**
 Apically enlarged hairs nearly half as long as breadth of head.....**rapae.**

Table of species, based on the mature caterpillar.

Mediodorsal stripe indistinct, only marked by the absence of black points; two hinder divisions of abdominal segments separated by a distinct, transverse crease.....**oleracea.**
 A distinct yellow mediodorsal line; two hinder divisions of abdominal segments separated by a very indistinct, transverse crease.....**rapae.**

Table of species, based on the chrysalis.

Lateral prominences of third abdominal segment distinctly flaring; mesial thoracic carina with a steep, anterior descent, at about a right angle with the under surface of the body.....**oleracea.**
 Lateral prominences of third abdominal segment scarcely flaring; mesial thoracic carina with a gentle anterior descent, at an angle of about 45° with the under surface of the body.....**rapae.**

Table of species, based on the imago.

Fore wings generally free of spots both above and beneath, but occasionally showing faint ones, especially above, and particularly in upper median interspace, where normal in the other species; tip of hook of male abdominal appendages curved strongly downward.....**oleracea.**
 Fore wings almost invariably with two large, round, black spots in the upper median and medio-submedian interspaces, both above and beneath, occasionally absent from the lower interspace; tip of hook of male abdominal appendages scarcely curved downward.....**rapae.**

PIERIS OLERACEA.—The gray veined white.

[The gray veined white (Gosse); pot-herb Pontia (Harris); garden ponty (Emmons); pot-herb butterfly (Minot); white butterfly (Fitch).]

Pontia oleracea Harr., New Engl. Farm., vii: 402 (1829); Ins. Inj. Veg., 3d ed., 269-271, fig. 99 (1862); Agass. Lake Sup., 386, pl. 7, fig. 1 (1860); Entom. corresp., 361 (1869).

Pieris oleracea Boisdu., Spec. gén. Léop., i: 518 (1836);—[D'Urb.] Can. nat. geol., ii: 347 (1857);—D'Urb., ibid., v: 243 (1860);—Morr., Syn. Lep. N. Amer., 19, 315-17 (1862);—Scudd., Proc. Bost. soc. nat. hist., viii: 178-80 (1861); Butt., 165, figs. 10, 44, 138, 139 (1861); Mem. Bost. soc. nat. hist., iv: 66 (1867);—Linn., Proc. entom. soc. Philad., ii: 62-4 (1864); Ent. notes, i: 28-29 (1872);—Reak., Proc. entom. soc. Philad., vi: 131-2 (1866);—Rhl., Rep. Ins. Missouri, ii: 105-6, figs. 75-76 (1870); Rep. U. S. dep. agric., 1883, 115-117, pl. 10, fig. 5 (1883);—Fitch, Trans. N. Y. st. agric. soc., 1868, 534-542 (1870);—Glov., Rep. U. S. dep. agric., 1870, 72, fig. 37 (1871);—Beth., Rep. ent. soc. Ont., 1871, 24, figs. 87-88 (1872); Can. ent., v: 37-39, fig. 7 (1873);—French, Rep. Ins. Ill. vii: 143-144 (1878);—Thom., ibid., ix: 26 (1880); Midgl. Midgl., x: 71, fig. 9 (1881);—Gosse, Can. ent., 37, 48-49 (1883);—Fern., Butt. Me., 27-28, figs. 2-4 (1884);—Mayn., Butt. N. Engl., 47-48, pl. 6, figs. 64, 64a (1886).

Ganoris oleracea Scudd., Syst. rev. Am. butt., 41 (1872).

Pieris napi (pars) Edw., Pap., i: 83-99, pl. 2-3 (1881);—French, Butt. east. U. S., 110-113, figs. 26-27 (1886).

Figured also by Glover, Ill. N. A. Lep., pl. 31, fig. 2; pl. 106, fig. 28 (3 figs.); pl. 27, fig. 7 (ined.).

[Not *Papilio napi* Linn.]

PIERIS OLERACEA FRIGIDA.
 The darker veined spring form.

Pieris frigida Scudd., Proc. Bost. soc. nat. hist., viii: 181-182 (1861).

Pieris hulda Edw., Trans. Am. ent. soc., ii: 370 (1860).

Pieris napi form *bryoniae* var. *hulda* Edw., Pap., i: 98, pl. 2, fig. 5 (1881).

Ganoris oleracea var. *borealis* Grote, Bull. Buff. soc. nat. sc., i: 185 (1873);—Coup., Can. ent., vi: 56-59 (1874).

Pieris napi form *oleracea hiemalis* Edw., Pap., i: 90, pl. 2, fig. 8 (1881).

Pieris virginianensis Edw., Trans. Am. ent. soc., iii: 13-14 (1870); Butt. N. Amer., i, *Pieris* 2, figs. 6-8 (1871).

Gonoris virginiensis Scudd., Syst. rev. Am. butt., 42 (1872).

Pieris napi form *oleracea-hyemalis* ab. *virginiensis* Edw., Pap. 1:98 (1881).

PIERIS OLERACEA CRUCIFERARUM.
The slightly marked summer form.

Pieris cruciferarum Bois., Spec. gén. Lép., 1:519 (1836).

Pontia casta Kirby, Faun. bor-amer., iv: 288, pl. 3, fig. 1 (1837).

Pieris casta Morr., Syn. Lép. N. Amer., 19 (1862).

? *Pieris marginalis* Scudd., Proc. Bost. soc. nat. hist., viii: 183 (1861).*

Pieris napi form *acadiæ* Edw., Pap., 1: 87, pl. 3, figs. 10, 11 (1881).

Pieris napi form *oleracea-aestiva* Edw., Pap., 1:93, pl. 3, figs. 15-16 (1881).

Over the fields where the brown quails whistle,
Over the ferns where the rabbits lie,
Floats the tremulous down of a thistle,
Is it the soul of a butterfly?

See! how they scatter and then assemble;
Filling the air while the blossoms for,
Delicate atoms, that whirl and tremble
In the slanting sunlight that skirts the glade.

There goes the summer's inconstant lover,
Drifting and wandering, faint and far;
Only bewailed by the upland plover,
Watched by only the twilight star.

Come next August when thistles blossom,
See how each is alive with wings!
Butterflies seek their souls in its bosom,
Changed thenceforth to immortal things.

T. W. H.—*The Soul of a Butterfly.*

Imago (7: 3; 13: 2). Head covered above with long, dull white and blackish hairs, the latter less frequent, occurring mostly in longitudinal series down the middle of each half of the front and generally partially concealed by the whitish ones; sides of the head behind the eyes covered with white scales in a band which narrows above and backed by black scales in a band which broadens above, or white with intermingled black scales. Palpi white, above on the last joint and the apical part of the middle joint black, reaching over a little upon the sides, occasionally flecked slightly with black on the sides of the middle joint, the inferior fringe on the apical joint, the apical fourth of middle joint, and the apical portion of the fringe a little further toward the base black. Antennae blackish brown, along the upper inner surface uninterrupted; beneath and outwardly interrupted by dark castaneous, on the sides between the two heavily marked with white, on either side of the castaneous markings nearly or quite uninterrupted, although unequal elsewhere mostly confined to the basal half of the joints; club blackish brown, darkest beneath, the outer half considerably flecked with white toward the base, the apical joint wholly, the penultimate on the lower inner surface bright luteous. Tongue brownish fuscous, growing pallid next the base.

Thorax black covered above with bluish white hairs sometimes with a yellowish tinge; beneath with dull white and pure white hairs, occasionally tinged with yellow. Legs white, the apical half of the femora with a rather broad median stripe of black on the inner side extending to the extreme tip and a short, slender streak of the same close to the tip above, the upper outer edge of the tibiae with a faint blackish line, extending also along the sides of the tarsal joints, and in addition a distinct slender stripe along the inner edge of the under surface and the inner edge of the upper surface of the fore tibiae; the tarsi tinged faintly with yellowish brown; spines pale luteous; spurs the same, becoming castaneous on apical half; claws and paronychiae castaneous; pulvillus fuscous, pallid on pedicel.

Wings above white without lustre, almost immaculate, bathed in a scarcely perceptible tinge of greenish yellow. Fore wings broader and the costal and outer margin a little

*The figures by Strecker (Lép., pl. 8, figs. 6, 7) of Reakirt's *P. yreka* do not represent the insect described by me under the name of *marginalis*. My identification (cf. loc. cit. p. 62, note) was based upon memory only and was incorrect.

more curved than in the other species. Wings rather lightly powdered at the extreme base, but especially upon the nervures with dark griseous; the basal two-fifths to one-half of the costal border as far as the upper limits of the cell, and sometimes the upper base of the cell itself, similarly but generally more lightly flecked; the whole costal edge is blackish fuscous, besides which the apex of the wing is generally marked lightly with fuscous by a narrow edging at the extreme tip, or it is more extensively marked by a broad border to the tips of the subcostal nervures, sometimes deepening almost to blackish fuscous, but interrupted in the middle of the interspaces; very rarely there is a faint open cluster of dusky scales scarcely beyond the middle of the upper median interspace. Fringe uniform white. *Hind wings* very slightly and roundly angulated in the middle of the upper subcostal interspace, not conspicuously prominent in the upper half of the outer margin. Wings seldom so heavily begrimed with fuscous as the fore wings at the extreme base and sometimes wholly immaculate; only the outer half of the costal edge is dusky and occasionally there is a faint cluster of grayish scales just below the tip of the upper subcostal nervule; the darker markings of the under surface sometimes show through the delicate wing; fringe uniform white.

Beneath white, the apex of the fore wings and the whole of the hind wings delicately washed with faint, pale yellow. *Fore wings*: the yellowish wash, which is sometimes scarcely visible, affects nearly all the upper apex of the wing beyond the last divarication of the subcostal nervure, generally as far along the outer border as the middle of the upper median interspace, but sometimes nearly, though faintly, to the lower outer angle; the nervures crossing the yellowish field are generally narrowly bordered with fuscous, more broadly in the middle than at either end, their tips being but slightly fuscous. Fringe uniform white. *Hind wings* rarely wholly immaculate and uniform; generally the yellow is slightly deeper along the costal border than elsewhere and deepens to a faint orange over the precostal nervule, the inner border is a little paler than the rest of the wing, and in addition all the nervures, excepting sometimes the nervule closing the cell, are edged rather narrowly with grayish scales, while often an additional line of grayish scales crosses the cell longitudinally—the exact continuation of the lowest subcostal nervule, merging in the subcostal nervule a little before it reaches the base. Fringe uniform white.

Upper half of abdomen black, covered rather profusely above with white scales and hairs, mostly with hairs toward the base, on the sides with dull white scales; beneath white, covered profusely with white scales and hairs, sometimes tinged with yellowish. Upper organ of male abdominal appendages (35: 15, 16) reaching fully to the tip of the clasp; hook, as seen from above, tapering equally throughout in continuation with the centrum to a fine, slightly down-curved point. Clasp with the lower border entire.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 8.75 mm.						
Length of fore wings.....	23.	24.75	26.75	22.75	25.	26.
antennae.....	9.5	10.	11.25	10.	10.75	11.
hind tibiae and tarsi.....	6.	6.	6.75	6.3	6.4	6.5
fore tibiae and tarsi.....	4.25	4.35	4.7	4.35	4.45	4.5

Described from fifty specimens, of which 32 are ♂, 12 ♀.

Dimorphic forms. *PIERIS OLERACEA FRIGIDA*. This spring type differs from the autumn type in that the extreme base of both wings and the apex of the fore wings are more heavily marked inclining to blackish. But the greatest distinctions are to be found upon the under surface, which is almost invariably quite heavily washed with lemon yellow on the hind wings and the apex of the fore wings; it has also all the nervures of the hind wings heavily and broadly bordered with blackish fuscous; also the nervures of the apical half of the fore wings above the middle median nervule pretty heavily, and most of the others narrowly edged in a similar manner; it is a little smaller than the summer broods.

In the southern limits of the distribution of this butterfly the spring brood appears with no tinge of yellow upon the under surface excepting faintly along the costal mar-

glin of the hind wings; the nervures are as broadly, but by no means so deeply bordered with dark scales; it is a little smaller and has been described as a distinct species by Mr. Edwards under the name of *virgihensis*.

No yellow variety of this species has yet been detected, though they have been found in *P. rapae* (see *infra*) and in the European *P. napi* (see Schöyen, Ent. tidskr., vi: 140).

Accessory sexual peculiarities. The androconia (46: 39) are shorter and far stouter than in *P. rapae*; especially the contracted distal half is far stouter, being nearly half as broad as the broadest part of the lamina, usually broader than the basal lobes, with a broad, expanding, fringed border, the filaments of the fringe not crowded, distinctly enlarged apically; the basal lobes approach each other so as nearly to touch, enclosing the pedicel in a rounded opening.

Egg (65: 27). Florence flask shaped; largest just above the base, tapering gently almost to the summit, near which it tapers less and then terminates in a flattened top; there are thirteen longitudinal ribs .1 mm. apart at the widest, approaching each other above; transverse lines .02 mm. apart; surface nearly flat, shining, nearly smooth, very delicately shagreened. Micropyle rosette (68: 15) much like that of *P. rapae*, the only difference noted being in the width of the oval cells, which are at least .0127 mm. broad. Color pale greenish yellow. Height, 1.18 mm.; greatest breadth, .45 mm.; breadth at base, .355 mm., at summit, .23 mm.

Caterpillar. First stage. Head (79: 50) very pale greenish, almost pellucid, with a very few pellucid curving hairs about as long as the body hairs but pointed at tip; ocelli blackish fuscous; all the mouth parts pale. Body pellucid white with a yellowish tinge posteriorly; after eating, green. Hairs pellucid, erect, those of the first thoracic segment longer than the others and curved slightly forward; legs and prolegs pale. Length at birth, 1.3 mm.; afterwards, 2 mm.; breadth of head, .42 mm.; of body, .28 mm.; length of hairs, .12 mm.; breadth of same at tip, .01 mm.

Differs from the same stage of *P. rapae* in being slenderer, with shorter hairs whose apical enlargements are slenderer.

Second stage. Head uniformly pale yellowish green studded with scant, mingled white and black papillae, bearing dark bristles; ocelli black, and mouth parts only slightly infuscated apically. Body rather dark bluish green as far as the infrastigmatal fold, decidedly paler beneath, and mottled very faintly throughout with pale green annuli encircling the darker green or white papillae. Serial papillae white, bearing black bristles, infundibuliform at tip and ordinarily accompanied by a globule of fluid. Other hairs on the upper half of the body shorter and black or dark brown, those on the stigmatal fold pale. Prolegs and stouter portion of the legs of the color of the under surface; apical portion of the legs pellucid. Length, 6.5 mm.; breadth of head, .6 mm.

Third stage. Head (79: 51) green with sparsely scattered, mingled black and white hairs arising respectively from black and white papillae, some white ones much longer than the rest. Mouth parts pellucid green. Body green with a yellowish tinge, stained with obscure reddish blotches of darker green somewhat regularly disposed dorsally. There is a distinct yellow dorsal line and a less distinct dull yellow stigmatal line, set off by a dark green bordering above. Whole body sprinkled profusely above with minute and slightly larger black papillae giving rise to delicate black and brownish hairs, mostly arranged more or less vaguely in transverse rows; and besides, with definite series of larger white papillae giving rise to bubble-tipped, longer, stiff, black, pointed hairs, viz., on anterior interodorsal (slightly nearer on first and second thoracic segments), a subposterior lateral, and an anteroventral sublateral (or laterostigmatal), all being central on the second and third thoracic segments. Below the stigmatal line the body is paler and the papillae are larger, white, very irregularly disposed and give rise to pellucid or whitish longer hairs. Spiracles with a fine, blackish brown annulus. Length, 10 mm.

Fourth stage. Agrees in all external appearances with the final stage. Length, 15 mm.; breadth of head, 1.3 mm.; of body, 2 mm.

Last stage (76: 8, 9). Head (79: 52) deep pea-green, covered with brownish hairs

and with a few white papillae, giving rise to other hairs; basal joint of antennae of the color of the head, beyond pellucid, slightly infuscated; ocelli black or green annulated with black; mandibles black at tip.

Body deep pea-green, profusely dotted with minute, inconspicuous black specks, often surrounded with darker green, from each of which arises a short, delicate hair, whitish on the sides of the body, mixed whitish and brownish on the summit; occasionally on the anterior abdominal segments there is an inconspicuous dorsal line free of black dots; and there is also a very faint stigmatal, pale-green line free of the black dots. Under surface pale green, concealed slightly by a pale whitish bloom. The first thoracic segment has a number of white papilliform warts, each emitting a moderately long, forward curving, brownish hair; the second and third thoracic segments have each a row of hair bearing white papilliform warts, viz.: subdorsal, lateral and suprastigmatal rows, one on the anterior edge of each segment; on the abdominal segments there are also similar warts on each side, one to a segment: a latero-dorsal placed anteriorly, a lateral placed posteriorly and a laterostigmatal placed centrally; they are also abundantly distributed beneath the stigmatal line and on the terminal segment. Spiracles luteous, edged with blackish brown and narrowly annulated with yellowish. Legs black, the claws reddish. Prolegs delicate pea-green, much like the under surface of the body. Length, 17.5 mm.; breadth, 2.5 mm.

Chrysalis (84: 57, 63, 64). Pea-green, darkest on thorax, the posterior abdominal segments paler, the wings and frontal tubercle pale greenish yellow; or dull brownish green throughout; whole upper surface covered with minute, circular, shallow impressions, not crowded together, either mostly concolorous with the body, pale fuscous on the thorax and to some degree on the sides of the abdomen, or black throughout; a roundish fuscous spot, distinctly limited in front only, is situated on the second abdominal segment at the origin of the suprastigmatal ridge, and the fourth to ninth segments are sometimes dashed with brownish fuscous on the sides above the suprastigmatal ridge; the nervures in the outer half of the wings are each marked with two or three distant black dots; sometimes the basal tubercle and the lower edge of the wings are streaked with brownish fuscous and an irregular black spot occurs near the tip. Antennae and legs pale, the base of the former obscured with fuscous, the latter tipped with fuscous; tongue scarcely surpassing the wings; frontal tubercle tapering pretty regularly throughout, curved upward, nearly twice as long as broad, sometimes streaked externally with brownish fuscous, the color extending over the eyes. Dorsal ridge of pronotum fuscous in the middle; of mesonotum dull yellowish, fuscous in the middle, the highest point of the ridge more elevated than in rapae; of metathorax blackish fuscous; or sometimes the ridge is of the color of the body and only tinged slightly on the highest parts with yellowish brown; median carina of abdomen pale; lateral ridge of thorax obscured with fuscous; suprastigmatal ridge of abdomen yellowish fuscous, interrupted with fuscous on the second and third segments; beyond, pale; the raised portions of the second and third segments well rounded. Abdomen beneath dotted with larger and smaller black dots, the former arranged in longitudinal rows; spiracles with pale lips; whole cremaster pale; hooklets pale testaceous. Length 19.5 mm.; of frontal tubercle, 1.6 mm.; width at mesothorax, 4 mm.; at third abdominal segment, 5 mm.; height of thoracic tubercle, 1.3 mm.; of mesothorax, 5 mm.

Comparison with allies. As this butterfly has been regarded as identical with *P. napi* of Europe by some who have studied only the markings of the wings, I have thought a comparison based on the early stages, some of them drawn from structural features, which look in quite the opposite direction, would be sufficient warrant for my retention of a distinction long held.

The mature caterpillar of *P. oleracea* differs from that of *P. napi* of Europe in the more uniform pile with which the body is clothed, and by the apparent

absence of those comparatively large, conical wartlets, ten or twelve times larger than the smaller ones, which form so conspicuous a feature in both *P. napi* and *P. rapae*, and which are arranged at subequidistant intervals in a transverse row on each of the subsegments of the body; they are present in *P. oleracea*, but are not nearly so large relatively as in *P. napi*, except possibly on the stigmatal subsections of the anterior part of the body, and are further inconspicuous in being either concolorous with the body, or white, or only a little infuscated, while in both the other species mentioned they are piceous and most conspicuous; occasionally, however, when white, they are marked with a fuscous annulus around the base and so are made more conspicuous, but herein they approach the normal type of *P. rapae* and not of *P. napi*.

The chrysalis of *P. oleracea* differs from that of *P. napi* of Europe, first, in the following structural features: the frontal tubercle curves distinctly upward, as shown in pl. 84, fig. 57, while that of *P. napi* is directed straight forward; the elevation of the suprastigmatal carina to a distinct, spinous, compressed tubercle on the sides of the anterior part of the third abdominal segment, is far more marked, and the tubercle itself distinctly flares laterally, which that of *P. napi* cannot be said to do. Second, in colorational peculiarities: Chrysalids of *P. napi* are far more heavily marked; especially the suprastigmatal carina is margined interiorly with large, blackish fuscous patches, forming a more or less interrupted band over the second to the eighth abdominal segments; the fourth to the tenth segments have a distinct, mediodorsal black dash at the anterior margin; and the disk of the wing cases is marked with a double black dash besides the black specks; none of these markings are present in *P. oleracea*, except the first named, on the second and third segments, and occasionally a fuscous indication posterior to that; the black specks or dots are found on the wing cases, but the black dashes are wanting. The further dorsal markings of the abdomen of *P. napi* consist, on most of the segments, of a curving or diverging series of black dots, three on a side next the middle line above, open posteriorly, and an oblique arrangement of two black dots on either side, nearer the suprastigmatal than the mediodorsal carina, the anterior marginal or submarginal and the outer, the other antero-central and the inner; none of these except the submarginal dot of the outer series is found at all in *P. oleracea*, and then only, as a general rule, on the third to the sixth segments, and accompanied on the fifth and sixth by a companion dot, sometimes double, a little way above the spiracle.

The male imago of *P. oleracea* differs structurally from that of *P. napi* in the hook of the upper organ of the abdominal appendages, which is shorter and more strongly curved at tip, while the semicorneous expansion of the under edges of the base is not a downward directed, vertical lamina, thickening into a posterior, downward directed thorn, but a short curved hook, opposed to the hook of the upper organ.

Geographical distribution (26: 5). This butterfly is a member of the Canadian fauna and also occupies the upper half of the Alleghanian and extends from the Atlantic Ocean to the Rocky Mountains, where it has occurred in Colorado at Pike's Peak (Reakirt), Empire City and above timber (Putnam), Fairplay (Mead), Leavenworth and Georgetown (Seudder); in Utah at Ogden Cañon (Osten Sacken), American Fork Cañon (Seudder), Summit Cañon (Putnam), Salt Lake (Packard), and Beaver Mountains (Palmer), always above eight thousand feet; in New Mexico (Snow), and in Montana at Virginia City (Reakirt). Excepting in the Rocky Mountain region, it is rare south of 42° N., though it extends in the east to Staten Island (Davis), Pennsylvania (Seudder) and West Virginia (Edwards). West of the Alleghanies its southern limits would seem to be about the southern shores of the Great Lakes, where it is reported from Toledo, O. (Kirtland), southern Michigan, common (Harrington), northern Illinois (Worthington), Madison, abundant (Kirtland) and Racine, Wis., to the south of which is "found but little" (Hoy), and Iowa (Parker). In the interior of the continent north of our boundary it stretches from ocean to ocean and evidently infringes on the Huronian fauna, for it is found from eastern (Packard) and southeastern Labrador (Couper), Anticosti (Couper), Newfoundland (British Museum, Gosse), Cape Breton (Thaxter) and Nova Scotia (Jones), by way of the southeastern shore of Hudson Bay (Drexler), Albany River (British Museum), the Athabasca country (Geffeken), Mackenzie River at 65° N. L. (Kirby), Great Slave Lake (British Museum) and even on the Arctic coast about 68° W. (Richardson) to Alaska (Dall); though perhaps these last may belong to the allied Pacific species, *P. venosa*. Along the southern boundary of the Dominion of Canada it is everywhere found, from the southern side of the St. Lawrence Gulf (Couper), by Quebec, Montreal, Toronto, London, Nepigon and Manitoba to Lake Koutenay (Geddes), Lake La Hache (Crotch) and Vancouver Island (Agassiz).

It is found throughout New England although seldom abundant south of the annual isotherm of 48° . Northward and eastward it is everywhere abundant and it continues to be so as far south as Williamstown, Mass. (Seudder), Dublin, N. H. (Leonard) and Portland, Me. (Seudder, Verrill). South of 42° N. L. or the northern boundary of Connecticut, it rarely occurs, although it has been taken at Farmington, Conn. (Norton), Newport, R. I. (Miss Coggeshall teste Higginson) and Fire Island Beach, Long Island (Smith). Even in the north, however, there seems to be some local causes for its abundance. Dr. Packard has seen but a single specimen in several years collecting at Brunswick, Me., and Prof. S. I. Smith has "never seen it common at Norway," Me., while it may be found in profusion at Portland, Me. In Milford, N. H. Mr. C. P. Whitney, a collector of long experience, has seen only two specimens, while in the neighboring

town of Dublin it was found common enough by the late Rev. Mr. Leonard. Possibly this may depend wholly upon mere annual variation; thus, Mr. Lintner, writing in 1864, says that in Schoharie, N. Y. "it was extremely rare until recently", and previous to 1857 "he had taken it but once in three years; while at present it ranks next to *philodice*"; later, however, he writes: that "for the last few years it has not been at all abundant at Schoharie, in marked contrast with some former years"; and Mr. Bacon of Natick, Mass., says that the insect by no means disturbs cabbages and turnips as it did fifteen or eighteen years ago.

The preceding paragraph is left as it was written many years ago at about the time that *P. rapae* first invaded New England. The story of the abundance and probably the distribution of *P. oleracea* would now be a very different one, for the invader has nearly exterminated the indigenous species. I recollect once seeing the college yard in Cambridge—I think it was about 1857—fairly swarming with *P. oleracea*. It is now never found to my knowledge anywhere in the region about Boston and I think it is wholly confined to the less cultivated and especially the hilly districts of New England. I should be surprised to meet it elsewhere; and even in the recesses of the White Mountains I have never in recent years seen it at all abundant, or so common as *P. rapae*. Formerly it occurred in profusion about Portland; Lyman reports it as very scarce in the six years following the advent of *P. rapae*. Mr. Lintner writes me that he was surprised to find *oleracea* quite common in August 1887, at Lake Pleasant in the Adirondacks, having rarely met with it since *rapae* was introduced; its numbers, however, were even then only half those of *rapae*. And Mr. Edwards states that since *rapae* reached West Virginia not a single example of the form he has called *virginiensis* has been seen there, though diligently sought for.

Oviposition. The eggs are laid erect on the under surface of leaves, not on the ribs, often several on a leaf and occasionally somewhat near together. Specimens from Schoharie were sent me many years ago by Mr. Lintner. His own account of them is as follows:—

With few exceptions, the eggs were placed on the under side of a leaf, so near the edge as to render it probable that the butterfly in ovipositing alights on the margin of the upper surface, and bends her body over its edge to place her egg on the less exposed under surface. Usually but one occurs on a leaf, but occasionally two or three are found so near together, as to indicate their having been deposited at the same time.

They hatch in from five to eight or ten days. Gosse once saw a female laying her eggs.

She alighted on the under side of a leaf of horse radish, and immediately, bending her abdomen down, touched the leaf for an instant, and flew away. Looking at the spot I found the white egg adhering by its end. I have had females lay several eggs when pinned on the setting board.

Fitch gives a slightly different account (Rep. ins. N. Y., xiii: 533.):—

Alighting, it stands upon the edge of the leaf, and bending its body downward it touches the tip of the under surface of the leaf, planting an egg thereon, placing it from an eighth to a quarter of an inch inward from the edge of the leaf. From one to three eggs, placed slightly apart from each other, are thus glued to the under side of the leaf, when it again takes wing and searches out another leaf such as it desires.

Couper says that the eggs are always laid on the upper side of a leaf and that he has found as many as five on a leaf. Mrs. Charlotte Taylor, according to Riley, "has never found the eggs deposited in any place except just where the leaf joins the cabbage stalk, down in the rim of the midvein."

Food plants. This caterpillar feeds on various cultivated cruciferous plants, such as turnip (*Brassica rapa*), cabbage (*B. oleracea*), radish (*Raphanus sativa*), horseradish (*Nasturtium armoracia*) and mustard (*Sinapis*). Mr. Lintner considers that it prefers turnip to cabbage, for he once obtained fifty eggs from a turnip bed and could find none on adjacent cabbage plants of the same age, and this has been my experience. Hoy, on the other hand, thinks it is found mostly on mustard. But it also occurs on some of our native plants, such as *Arabis drummondii* (Couper) and *A. perfoliata* (Fletcher), and Fitch says it occurs abundantly on the water cress (*Barbarea vulgaris*). In Colorado I saw the female lay an egg on *Caltha leptosepala*, one of the *Ranunculaceae*.

Habits of the caterpillar. The escaping caterpillar eats its way through a hole just large enough for egress, in one side near the summit of the egg, and then usually devours most of the remainder. Mr. Lintner watched one make its way out.

For a half hour it was seen to be vigorously plying its black-tipped mandibles on the interior surface next the apex, before it effected an opening. The opening made with so much labor was rapidly enlarged by the larva eating a sufficient portion of the shell to permit its egress. Immediately upon having wholly withdrawn itself, it resumed its feeding upon the shell, nearly all of which it consumed.

The first stage lasts but two or three days, and it takes it but about two weeks or a little more to reach maturity, whether in the first brood or the second. Fitch says (loc. cit.):—

It eats small, round holes through the leaf when it is young, larger and less regular ones as it advances in size and approaches maturity. It feeds mostly by night and remains at rest during the day, frequently standing in the groove made by the midvein on the upper side of the cabbage and turnip leaves, with its head downward, toward the base of the leaf. But if there is a fold in the margin or any other covert where it will be more hid from view, it conceals itself therein. It resorts to the same place upon the leaf day after day, spinning and fastening to the surface an exceedingly fine web of silken threads, to give it a more secure foothold. It moves about but little, crawling very slowly, with its mouth to the surface on which it is crawling, placing there a silken thread to aid it in clinging. It seldom quits the leaf on which it is placed, if this is of sufficient size to fully feed it.

The early stages are more quickly passed than the later, and the larva

at all times feeds to repletion, so that the skin of the body is tense and glistening when it has finished a meal. It never eats the leaf at the edges, and generally or always leaves the veins untouched, feeding upon the under surface only.

When about to change to chrysalis the caterpillar seeks the under surface of boards or garden fences protected by weeds, and may often be found in considerable numbers in dry and sheltered places.

Pupation. Fitch, in his Thirteenth report on the insects of New York, gives such a careful account of the change to chrysalis in this insect, that we copy it in full:—

Having found such a situation as it requires, the larva determines in what position it will place itself to remain during its pupa state, for there is much diversity in our white butterfly in this respect, it being sometimes suspended upon the under side of a horizontal or an inclined surface, and at other times against the side of a vertical surface; and it is held in a variety of positions, horizontal, oblique, or almost perpendicularly upward or downward, usually with its back, but sometimes with its right or its left side downward.

Having selected the spot it will occupy and the position in which it will suspend itself, it requires a loop to be made around its body to hold it in this position. To give its feet the secure foothold they will require while this loop is constructing, it first spreads a slight carpeting of silk threads upon the surface on which it is to stand, forming also at its lower end a thick mass or little hillock of these threads. It then fastens the hooks of its hind feet securely into this mass of threads, and clinging to the carpeted surface with its middle legs, its body is so very soft and flexible that it is able to bend and turn its head backward, touching either side or the top of the back at a point one-third of the distance from the hind to the fore end. And with its head thus turned backward it fastens to the surface, at one side of its body, a thread of silk which it spins from its mouth. It then carries its head up over its back and down upon the opposite side of the body, where the mouth fastens the other end of the thread, thus forming a loop around its body, holding it to the surface on which it is standing. This single thread, however, is exceeding fine and possessed of but little strength. The worm therefore carries its mouth back again by the same route, to the opposite side, thus spinning a second thread, with its end fastened at the same point where the first one was commenced. And it thus continues to move its mouth from one side to the other, until it has formed a skein of threads of sufficient size and strength to securely sustain the weight of its body. Reaumur states the number of threads in the loop to be about fifty. But in our American species there is no uniformity in this loop, it being in some instances not a fourth the size that it is in others. If the larva gains some secluded corner where it will experience no molestation, it does not trouble itself to spin but a few threads to form this loop.

The most laborious part of this work, and that which occupies the principal part of the time that this loop is being constructed, is the fastening of the ends of the threads to the surface on each side of the worm. As the tension upon the threads is almost directly upward, it has a strong tendency to tear them from their attachment, and the worm shows particular care in fastening the ends securely, applying its mouth to the surface at numerous points, to glue the thread thereto, whereby a dense web comes to be formed upon the surface around each end of the loop. The worm, moreover, moves its body from side to side with each thread that is spun. When a thread is about being fastened upon the right side, to give the mouth the requisite room for attaching it to the surface, the body is crowded to the left, as far as the threads already spun will admit, thus putting these threads on the stretch, whereby the worm will ascertain if it is fastening them sufficiently secure.

Having completed its skein of threads, the larva straightens itself, and it is then noticed that about two-thirds of its length is forward of the skein. It now becomes quiet and motionless, but its body gradually contracts in length, whereby, at the end of an hour or two, its anterior part is found to be but half as long as it previously was, the skein now girdling it around its middle. It has also undergone a sensible change in its form, that portion which is forward of the girt being thicker and cylindrical, whilst that which is back of it is gently tapered.

The larva remains in this position, with its hind feet fastened into the little hillock of silk threads at the end of its body and the loop around its middle, from twenty to thirty hours. Then, with some writhings and contortions, a cleft is opened in the skin on the upper side of its neck, which crack soon extends along the middle of the head and the fore part of the back, forming an orifice of sufficient size to allow the body to pass out through it, and when the head is also disengaged, it rests upon the old skin of the larva. The pupa now, by contracting and elongating itself, rapidly crowds the skin backward, crumpling it together underneath its body, until only the conical hind part remains upon the pupa. Being securely held by the loop of silk which is now around it, the pupa readily withdraws the tapering hind end of its body from the remainder of the larva skin, and the tip of its body being furnished [on the] under side with a number of minute hooks, it pushes these backward beyond the shriveled remains of the larva skin, and fastens them into the little wad of silk threads to which the larva skin is also attached by the minute hooks of the hind feet. This larva skin, being now a crumpled mass of membrane and hairs, discommodates the pupa by being crowded as it is under and around the hind end of its body. In order to remove it, therefore, the end of its body being bent into a curve at this time and fastened at its tip, it moves this part of its body around and around, in a rotary manner as it were, thus crowding against the pellet of old skin, dislodging it from its former place, and gradually breaking it off from its connection with the little bundle of silk threads. It continues this motion some little space of time, to accomplish this purpose—over a half minute, I should judge it to have been, in the instance which I witnessed. At length the crumpled mass, having become rolled into a little wad no larger than a kernel of allspice, becomes entirely detached and falls to the ground.

As yet the pupa retains the shape of the larva, being thickest anteriorly and gradually tapered to the tip, without any angular projections upon the back, only the horn at the anterior end and the wing sheaths having their pupa development. But the protuberance upon the back of the thorax case soon begins to appear, and shortly after this a slight angular projection becomes perceptible upon each side of the middle of the back. These gradually become more prominent, and in a short time the whole surface becomes molded into its normal pupa form. (Rep. Ins. N. Y., xiii: 536-538.)

Gosse once found one "bound in a perpendicular position head downward to an upright post." The girt, which in the chrysalis is always found in the middle of the first abdominal segment, is in the caterpillar before pupation found either in the middle of the same segment or in the incision between it and the second.

Life history. This butterfly, which appears to be generally triple brooded, passes the winter in the chrysalis; the first brood has been seen as early as April 18, but usually appears between April 27, and May 9, a week or thereabouts after *P. rapae*. For several years Fitch observed it at East Greenwich, N. Y., for the first time on May 8 and 9 and only once as early as May 6; in northern localities it is sometimes a little as the third week in May. It usually becomes abundant between the 10th and 15th of the month and continues until the end of the first week in

June. The eggs are laid during the last half of May and early in June, and hatch in from five to ten days; the caterpillars may be found from the last week of May to the end of June, the chrysalis hangs from seven to eleven days and the second brood of butterflies makes its advent during the last days of June or very early in July, a few days after the appearance of the second brood of *P. rapae*; this brood in *oleracea* seems never to be very abundant (ordinarily less so than the first brood) and to maintain itself for a comparatively short time; it becomes common by the end of the first week of July, or, in the north, a few days later, and sometimes disappears, in the south at least, before the end of the month. The eggs are laid throughout July, and some of the larvae are full grown before the last week of the month; indeed these caterpillars always grow rapidly, usually attaining their growth in two or three weeks; some larvae may still be found throughout the first half of August. The third brood sometimes appears as early as the last days of July, but usually not before August; it becomes very abundant by the middle of the month and lasts until early in September. The eggs are laid during the middle and latter part of August; the caterpillars are found from the last week in August to the first week in October, and begin to change to chrysalids as early as September 8 and pass the winter in this condition. Occasional specimens, however, disclose butterflies late in September or early in October. These are probably all males (for the male of this species usually appears a week earlier than the female), but in any case this brood must perish, for only the chrysalis can endure the severe frosts; this apparition of a false brood has been known to occur as far north as Norway, Me. (Smith).

The species must be triple brooded far to the north. Jones says it is abundant in August in Nova Scotia, which rather indicates the third brood; on the lower St. Lawrence, Bell found butterflies at St. Simon on May 28 and again at St. Anne from June 20 to the middle of July, showing that there must be three broods there. At Ottawa it appears as early as May 22. On the other hand in southern Labrador Couper thought there was one only, but in this he was perhaps mistaken; the butterfly appeared in the latter part of June and flew to the middle of July and specimens showed that this was the spring brood. In Newfoundland, according to Gosse, it appeared only a little earlier than that, "early in June," and he found a second late in August and early in September. At Nepigon, north of Lake Superior, it can hardly appear much before the middle of June and eggs obtained by me the first of July laid by the first brood and transported to Cambridge gave the imago the same month; and as Osten Sacken took the butterfly in September at Duluth, it is highly probable that there is a second brood at Nepigon. Mead first met with the butterfly in his Colorado collections on June 12 and found it flying through July, and he adds, "there is no second brood"; but these specimens, like

my own and Osten Sacken's taken in Colorado and Utah during July and up to August 3, where I found it only above 8500 feet, were all of the summer type and undoubtedly belonged to a second brood; and comparison with the dates at the east makes it most probable that there is also a third brood there.

Habits, flight and behavior of the butterfly. The butterfly is constantly seen flying about garden plots in the vicinity of turnip beds, but its native haunts are the borders of thin woods where wild Cruciferae grow. In the White Mountains one quickly notices the difference in this respect between it and *P. rapae*, the latter confining itself almost exclusively to the neighborhood of houses or the high road, in contradistinction to the habits of the present species, which prefers open places in the woods and forsaken roads through them, seldom occurring in the vicinity of cultivated ground. In keeping with this it seems to be a far more timid species than *P. rapae*, being very wary of approach and also a swifter species in flight; it is as if in its partial supplanting by *rapae* it felt that "every man's hand was against it," and it had become a misotheorian. Riley gives the following account of its habits (Report, 1883):—

The butterfly flutters about during the day, especially in the gardens and over the beds of plants upon which its eggs are to be laid. It is said to be remarkably pugnacious in disposition, and whenever a dozen or more are quenching their thirst around a small puddle, a fierce battle is sure to ensue. The butterflies begin by jostling one another, striking their antennae together and flapping their wings, then the *wilde* commences, and often becomes so deeply interesting that some enemy, a bird or a dragonfly, pounces upon and devours one-half of the struggling combatants before the others have discovered the ill-omened presence.

Harris describes it as flying "slowly and lazily, especially when laying" its eggs. According to Lintner it begins its daily flight at an earlier hour than any other butterfly, often before seven o'clock, and is seen abroad until late in the afternoon. Mr. Lintner has observed its partiality for the blossoms of burdock, and D'Urban speaks of its habit of pitching upon the dead fish and offal lying round his camps in the woods.

When at rest on a vertical surface, it holds the wings erect, the hind edges of the hind pair resting on the surface, the antennae spread at right angles and parallel to, but raised a trifle above, the line of the trunk; beyond the curved base they are as straight as a rod; the trunk is held at an angle of about 45° with the surface, but the abdomen hangs freely.

One evening after dark Gosse saw in Newfoundland one of these butterflies resting with closed wings on a stalk of grass; he threw it into the air repeatedly, but it would not fly; it merely fluttered to the ground, and made no resistance to his taking it up again.

Dimorphism. The summer broods of this species are almost pure white, while the spring brood, besides being smaller, has the under surface of the hind wings and of the tip of the fore wings heavily washed with yellow, and all the veins in the same area broadly sprinkled with dark

scales. In the colder parts of its range, the second brood is more like individuals of the first brood farther south, and at the southern limits of its range the spring butterflies are far less heavily marked than in the north. In both this species and the next the hind wings of the second generation are longer than those of the first.

Enemies. The only parasite of this butterfly which is known is *Apanteles glomeratus* (88: 12), whose action, according to Riley, is described by Mrs. Charlotte Taylor in a popular article in the *American Agriculturist* for 1860. But Gentry says that many birds feed upon it both in the larval and perfect stages and several species feed it in large numbers to their young; but it is more than doubtful whether he correctly distinguished this species from *P. rapae* when examining larvae from a bird's stomach. The principal enemies, in his view, are the robin, *Merula migratoria*, the wood robin, *Turdus mustelinus*, the blue bird, *Sialia sialis*, the redstart, *Setophaga ruticilla*, the chipping sparrow, *Spizella socialis*, the great crested fly-catcher, *Myiarchus crinitus*, the king-bird, *Tyrannus tyrannus*, and the night hawk, *Chordeiles virginianus*.

Desiderata. The relation of this butterfly to *P. rapae*, the foe of its own household which has arisen in these latter days, is an important one. Undoubtedly its decimation has been related in some way to food supply, and a study of the relation of the two species to other plants than cabbage, especially if they be indigenous, would be interesting. Is there any indication, where the two occur, that the broods of oleracea are beginning to appear earlier than formerly, in order the better to compete with *rapae* which has now first choice of plants; very careful observations in uncultivated territory for a score of years would be needed to settle such a point. What is the cause of the relative poverty of the second brood. Do any of the June chrysalids persist, to swell the third brood of butterflies? Do the occasional members of a fourth brood ever lay eggs, and if so, can the caterpillars from them ever go forward to chrysalis? The line separating digoneutism from polygoneutism should be made out. With the overbalance of *rapae* it would now perhaps be impossible to determine whether in the southern Alleghanies the form *virginiensis* has other broods the same season, which Mr. Edwards denies, but which it is difficult not to believe.

LIST OF ILLUSTRATIONS.—*PIERIS OLERACEA*.

General.

- Pl. 26, fig. 5. Distribution in North America.
88: 12. *Apanteles glomeratus*; a parasite.

Egg.

- Pl. 65, fig. 27. Plain.
68: 15. Micropyle.
Caterpillar.
Pl. 76, figs. 8, 9. Full grown caterpillar.
79: 50-52. Head, first stages, i, iii, v.
86: 82. Mandible of caterpillar at birth.
44. Dermal appendage, first stage.

Chrysalis.

- Pl. 84, fig. 67. Side view.
63-64. Outlines.

Imago.

- Pl. 7, fig. 3. *P. o. cruciferarum*, ♀, both surfaces.
13: 2. Upper surface.
35: 15, 16. Male abdominal appendages.
40: 7. Neurulation.
46: 39. Androconium.
56: 6. Side view, with head and appendages enlarged, and details of leg structure.

PIERIS RAPAE.—The cabbage butterfly.

[The cabbage butterfly; the imported cabbage butterfly; the European cabbage butterfly (vulg.); the small white (English); the rape butterfly (Minot); the garden white butterfly (Ross).]

Popilio rapae Linn., Syst. nat., 10th ed., 408 (1758).

Pieris rapae Schrank, Fauna boica, i: 1: 165 (1801);—Boisd., Spec. gén. Léop., i: 520 (1836);—Bowles, Can. nat., n. s. i: 258-262 (1864);—Ritch., ibid., iii: 293-300 (1867);—Min., Am. ent., ii: 75-76, figs. 48-50 (1870);—Ril., Rep. ins. Mo., ii: 107-110, figs. 77-79 (1870);—Rep. U. S. dep. agric., 1883, 108-113, pl. 1, figs. 1, 1 a-d (1883);—Glov., Rep. U. S. dep. agric., 1870, 78-79, fig. 36 (1871);—Fern., Butt. Me., 29-31, figs. 5-7 (1884);—French, Butt. east. U. S., 114-116, figs. 28-30 (1886);—Mayn., Butt. N. Eng., 47, pl. 5, figs. 63, 63a (1886);—Seudd., Mem. Rost. soc. nat. hist., iv: 53-60, pl. 8 (1887). [Figured in all the reports on noxious insects, issued by state and national governments.]

Pontia rapae Fabr., Ill. mag. ins., vi: 283 (1807).

Ganoris rapae Dalm., Kongl. vetensk. akad. handl., xxxvii: 87 (1816);—Seudd., syst. rev. Am. butt., 41 (1872).

Catophaga rapae Hubn., Verz. bek. Schmett., 93 (1816).

Andropotum corax rapae Hubn., Verz. eur. schmett., 8 (1822).

Figured also by Glover, Ill. N. A. Lep., pl. 100, fig. 18 (2 figs.); pl. 106, fig. 30 (3 figs.); pl. I, fig. 14; pl. N, fig. 2 (ined.).

PIERIS RAPAE METRA.

The spring form.

Pontia metra Steph., Ill. Brit. ent., Haust., i: 19-20, 146-147 (1827).

PIERIS RAPAE RAPAE.

The summer type.

Pieris rapae, as above, with most of the figures.

PIERIS RAPAE NOVANGIAE.

The sulphur variety.

Ganoris rapae var. *novangiae* Seudd., Can. ent., iv: 79 (1872).

Pieris rapae var. *novangiae* Seudd., Bull. Soc. ent. Fr., 1873, 57 (1873);—Streck., Lep., 64, pl. 8, fig. 8 (1874).

Fly, white butterflies, out to sea,
Frail pale wings for the wings to try,
Small white wings that we scarce can see
Fly.

Here and there may a chance-caught eye
Note in a score of you twain or three
Brighter or darker of tinge or dye.

Some fly light as a laugh of glee,
Some fly soft as a long, low sigh:
All to the haven where each would be
Fly.

SWINBURNE.—*A Century of Roundels. Envoi.*

Why, is not this a lament-
able thing, grandsire, that we should be thus
afflicted with these strange flies.

SHAKESPEARE.—*Romeo and Juliet.*

Imago (7: 11, 12; 16: 4, 5). Head covered above with mingled black, pale bluish white and pale yellowish white hairs; next the eye in front pale yellowish scales; behind the eye white-tipped black scales and hairs; sides of palpi white, the middle joint with a median black streak; terminal joint black above, sometimes with a slender, central white line, and furnished with a slender black stripe along the inferior edge of the sides; inferior fringe wholly white along the inner side, almost wholly white at base of palpus, but becoming more and more mingled with equally long, black hairs toward the tip on the outer side. Antennae rather narrowly black above, and in a narrow line along the outer under surface, dying out toward the club; along the inner under surface a nearly continuous series of bare fuliginous spots, tapering toward the tip of each joint; the rest white, narrowly interrupted with black at the tips of the joints; club black, flecked with a few pale bluish white scales above, especially toward the base, and with more beneath, the apical joint pale luteous, almost whitish.

Basal fourth of tongue pale luteous, fuscous-fuliginous, with a greenish tinge beyond; papillae (61:52) few, very distant, small, cylindrical, no longer than broad, with a small central filament.

Thorax covered above with pale plumbeous hairs, on the prothorax, and to some degree on the edges of the patagia, tinged apically with pale sulphureous, on the front of the rest of the thorax with pale greenish gray; beneath covered with pale greenish gray hairs, tinged slightly with yellowish, and mingled with a few blackish hairs; legs black, tinged with brown on the tibiae and tarsi, the femora tinged with greenish gray and a few black hairs, thickly covered with white scales tinged pretty strongly with yellow toward the base, and leaving a streak of black just above the middle of the outer half of the anterior surface, and a shorter apical streak on the posterior edge of the upper surface; tibiae thickly clothed with white scales, which are absent from two slender stripes down either side of the outer surface, in continuation of those of the femora, most distinct on the fore legs, least so on the hind; tarsi flecked with a few white scales; spines pale brownish luteous; spurs blackish castaneous at tip; claws and all the apical appendages blackish fuliginous.

Wings above dull white, occasionally tinged with yellowish, especially in the ♀; outer margin of *fore wings* nearly straight; the wings pretty heavily flecked with griseous at the extreme base, rather less heavily along the basal half of the costal border, as far as the upper margin of the cell; in the ♀ also faintly powdered with gray scales over the whole basal half of the wing, fading out apically; the costal edge is griseous; at the apex of the wing there is a blackish griseous spot, made up of a more or less dense sprinkling of dark scales, extending over a larger portion of the costal third of the outer border, and vaguely limited interiorly by a nearly straight line, running from a little before the extremity of the second superior subcostal nervule to the outer border at the middle of the lower subcostal interspace; scarcely before the middle of the upper median interspace is a round or quadrate, blackish griseous spot of varying intensity and size, but seldom equalling the width of the interspace; it is occasionally wanting in the ♂; in addition the ♀ has a similar, generally smaller and transverse, frequently geminate spot in the medio-submedian interspace, at a little more than half way from the base to the tip of the lower median nervule; usually it is connected at its lower extremity with a powdery, rather broad, longitudinal, griseous streak running to the base next the inner margin. Fringe uniform white. *Hind wings* scarcely angulated in the subcostal region, not conspicuously prominent in the upper half of the outer margin; wings flecked at the extreme base with griseous, as in the fore wings, generally extending outward a little further on the median nervule; in the ♀ the basal half flecked to some degree, especially along the median nervule, but less heavily than on the fore wings; on the costal margin, its outer limit at the tip of the upper subcostal nervule, a transverse oblique spot, similar in color and intensity to those on the fore wings, directed outward in passing downward, reaches nearly to the middle subcostal nervule. Fringe white.

Beneath, *fore wings* white, delicately tinged with lemon yellow at the apex of the wing, from half way between the apex of the cell and the tip of the wing; also generally, but still more faintly tinged with the same along the costal margin, and occasionally, in specimens where the upper surface is tinged with yellow, bathed very faintly throughout in yellow, deepest on the parts mentioned; a few griseous scales are scattered distantly over the whole wing, but especially over the basal half of the cell and along the basal two-thirds of the costal margin; the spots of the upper surface are repeated beneath, but almost invariably some trace at least of the spot in the medio-submedian interspace is found in the ♂ also; while at the same time the griseous streak which usually accompanies it above does not occur in the ♂, and but seldom, and then greatly diminished, in the ♀. Fringe white, occasionally a little yellowish. *Hind wings* pale or deeper lemon yellow, the basal third of the costal edge pale orange; the whole wing pretty uniformly flecked, sometimes very lightly, at others quite heavily, with griseous scales, generally less abundant in the apical fourth of the wing and in lines down the middle of the interspaces, and usually most con-

spicuous in a broad belt which follows the median nervure, extending above to the middle of the cell, and continues, on the apical half of the wing, in the same course—sometimes mostly restricted to the lower half of the cell. Fringe white or yellowish.

Abdomen above black, covered with bluish plumbeous hairs, on the last segment whitish; beneath pretty heavily flecked with white scales and a few hairs; upper organ of male appendages (35:10) reaching nearly but not quite to the tip of the clasp; hook tapering, as seen from above, on its basal half only, beyond equal, bluntly pointed and scarcely curved downward; clasp broadly and roundly but distinctly excised on middle of the lower border.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 11 mm.						
Length of fore wings.....	21.25	25.5	27.	22.5	23.	23.5
antennae.....	10.75	11.85	12.	10.85	10.75	11.
hind tibiae and tarsi..	6.	6.9	7.1	6.	6.2	6.4
fore tibiae and tarsi..	4.5	5.35	5.4	4.1	4.2	4.3

Described from 83, 3 ♀.

Seasonally dimorphic forms. *PIERIS RAPAE METRA.* Meyer Dür gives the following distinctions between the spring and summer broods (which I believe Zeller was the first to point out forty years ago) as they appear in Switzerland. The spring specimens are dull white; above, the apex of the fore wings is narrowly grayish, the bases of all the wings strongly sprinkled with black scales; the spot in the upper median interspace of the fore wings and the costal spot of the hind wings are small, generally pale grayish or even wanting; the under surface of the hind wings are dull yellow with black flecking, which, especially along the median nervure, is pretty heavy; the abdomen is clothed with long hairs.

PIERIS RAPAE RAPAE. The summer specimens are somewhat larger, of a more intense white, the apex of the fore wings above with a much broader margin of black or blackish; the spots mentioned generally larger and deeper in color, especially in the ♀, in which a grayish, shadowy streak follows the inner border from the inferior spot toward the base; at the base of the hind wings the black flecking scarcely appears at all; on the under surface they are uniformly pale yellow with hardly noticeable blackish fleckings in the median fold. The upper surface of the females is remarkably yellowish, the black spots and the apex of the fore wings much broader and deeper; the abdomen is more sparsely haired.

He adds that the presence, paling or entire absence of the spots on the wings (not including the apical markings) may be noticed in the males of both generations.

Bowles was, I believe, the first to note similar distinctions between the broods in this country. He says (Can. ent., iv: 103-104):—"The spring brood is of a much purer white than those produced later in the season, and has the blackish markings less in size and paler in colour. I have often seen spring males without the spot on the upper side of the fore wings, and having the blotch on the apex so much obliterated, that I have supposed them, before examination, to be *P. oleracea*. The spot, however, is generally present beneath, and can be faintly seen through the wing. As the summer passes, the markings of the successive broods become more intense, until in the autumn, individuals (particularly females), are met with which have a grayish appearance, from the number of black scales sprinkled on the wings, especially near the body.

Varieties. *PIERIS RAPAE NOVANGLIAE.* I have seen only males of a variety which is lightly marked with griseous, but has the upper surface uniform, delicate, canary yellow; and beneath, the fore wings, excepting at apex, a little paler, and the hind wings a little deeper than this; the basal third of the costal edge of the hind wings is pale orange and the wing is but lightly flecked with griseous; fringe of all the wings on both sides pale yellow. Females, however, are not unknown.

Bowles has also observed a seasonal distinction in this variety. He says (Can. ent.,

iv: 104):—"The spring specimens are of a very delicate yellow, almost without spots, and are very handsome, while those appearing in the fall are of a sulphur yellow and heavily marked."

Accessory sexual peculiarities. The androconia (46: 40) differ from those of *P. oleracea* in the far more slender distal half which is not a fourth the diameter of the broadest part of the lamina, produced, and hence with more crowded and fewer filaments to the fringe; these too are scarcely enlarged at the tip; the basal lobes hardly approach each other to clasp the pedicel, so that the sides of the gap between them are nearly equal instead of forming a partially enclosed rounded space, as in *P. oleracea*.

Egg (65: 28). Sugar loaf shaped; largest at about the middle of the upper two-thirds, tapering gently beneath to the docked base and much more rapidly above to the summit, where it terminates in a flattened top; there are twelve longitudinal ribs .1 mm. apart at the widest; transverse lines on the broadest part of the egg from .025 to .028 mm. apart; surface smooth, glistening, delicate. Micropyle rosette (68: 16, 17) .076 mm. in diameter, the central circle .0068 mm. in diameter, the oval cells .017 mm. long and .0115 mm. broad, the outermost largest; transverse cells about .04 mm. broad. Color pale lemon yellow deepest in color above with a slight greenish tinge, changing subsequently to a lemon yellow. Height, .98 mm.; greatest breadth, .46 mm.; breadth at base, .36 mm.; at summit, .09 mm.

Caterpillar. *First stage (72: 4).* Head pale greenish yellow covered with a very few dark brown or black slightly curving hairs, of variable length but some nearly as long as those of the body; ocelli black; mouth parts and antennae pale. Body very pale greenish yellow; as soon as they have eaten they become green; hairs of body (86: 43) a little arcuate, wholly pellucid, the ovate club of the upper rows larger than that of the others, seated on white warts; stigmata of the color of the body with a luteous annulus; legs and prolegs of the color of the body, claws of the latter dusky. Length, 1.6 mm.; breadth in middle, .28 mm.; behind, .25 mm.; of head, .36 mm.; length of clubbed hairs, .17 mm.; of simple hairs, .27 mm.; of hairs on head, either .04 mm. or .12 mm.; breadth of club of laterodorsal hairs, .021 mm.; of lateral hairs, .017 mm.; of wart at base of hairs, .025 mm.

Second stage. Head and body pale green, the latter with a slender, yellowish, dorsal stripe. Head with mingled black and white hairs springing from minute warts of same color; ocelli black; mouth parts and antennae pale; labrum pale; mandibles edged with fuscous. Abdominal segments with white warts arranged in a subdorsal strongly anterior, infralateral medio-anterior, and supralateral posterior rows, giving rise to black, straight not tapering, blunt tipped hairs; besides which the whole body is sprinkled with greenish fuscous warts from which spring shorter black or moderately long, tapering and delicately clubbed, pale hairs, the warts arranged in seven transverse rows on each segment, the anterior and posterior pairs of each segment closer together than the others. There is also a substigmatal anterior white wart giving rise to a pale hair. Spiracles luteous with a black ring. Legs and prolegs together with the claws of the body-color. Length, 9 mm.; breadth, 1.5 mm.

Third stage. Exactly the same as in preceding stage, except in size and that one or two small spots of yellow appear for the first time on each segment along the stigmatal line. Length, 14 mm.; breadth, 2.5 mm.

Last stage (76: 11, 12). Head (79: 53) of the body color profusely supplied with hair-bearing warts some of which are white; ocelli black, sometimes tipped with green; mandibles green, reddish brown at tip. Body of the green of a cabbage leaf, with a narrow, greenish, lemon yellow, dorsal band; a narrow, interrupted, stigmatal band of the same color; the whole body profusely dotted with larger and smaller wartlets, giving rise to very delicate, rather short, white or fuscous hairs, the larger ones arranged in transverse rows, also supplied with white wartlets each giving rise to a blackish hair, arranged in longitudinal rows one to each segment in a row, viz.: a subdorsal row on the anterior part of the segments, a lateral, placed posteriorly, and a suprastigmatal, placed centrally. Spiracles pale fuscous, edged with black. Legs green, the claws fuscous. Prolegs (86: 31) green. Length, 20 mm.; breadth, 4.5 mm.

Chrysalis (84: 58, 65). Whole upper surface very pale brownish yellow, or pale green, darker on the thorax, most profusely specked with minute, black, circular punctures, arranged on the abdomen in transverse rows frequently connected by narrow fuscous lines, and often washed more or less throughout with fuscous, giving the whole a blackish fuscous speckled appearance; minute, circular, black spots are scattered more or less conspicuously over the body; one just without the posterior base of the antennae; on the prothorax a divided dorsal, a subdorsal and a lateral one; on the mesothorax one at the base of the wings, a divided dorsal one on the highest part of the crest, which is rounded at the summit, and four arranged quadrilaterally on either side; on the metathorax four arranged quadrilaterally, the anterior upper one being thrown a little out of line and forming, with its mate, a divided dorsal spot; on either side of the abdominal segments, three or four are arranged in an oblique line from the anterior outer angle to near the middle of the posterior border and besides there is a pair of subdorsal central ones; from the ninth segment posteriorly the abdomen is white with a few minute black dots and an interrupted black dorsal streak; the wings are dark brown with a greenish tinge or greenish, somewhat infuscated from close dendritic figures of blackish fuscous on a paler ground; the veins are interrupted with black dots; front and appendages very pale greenish brown; some fuscous spots on the front and the antennae faintly interrupted with fuscous; tongue surpassing the tips of the wings by half a segment's length; frontal tubercle tapering rapidly at extreme base, beyond but slightly and so slenderer in general than in *oloracea*, more than twice as long as broad, edged externally and beneath apically with black; a narrow, pale yellowish, dorsal line, from the tip of the frontal tubercle extends backward over the whole body, interrupted occasionally with black or fuscous, with white followed by black on most of the abdominal segments, but almost altogether obscured on the second and third abdominal segments; suprastigmatal carinae of abdomen yellowish white, often interrupted with black, the raised portions of the second and third segments and especially of the latter elevated to a sharp point. Abdomen beneath very pale roseate or simply pale green, the eighth and succeeding segments whitish, almost devoid of spots; an interrupted black ventral streak; on either side three longitudinal rows of small blackish spots; spiracles pale with luteous lips. Length, 20 mm.; length of frontal tubercle, 1.5 mm.; breadth at thorax, 4.25 mm.; at third abdominal segment, 6.25 mm.; height at dorsal tubercle, 5.25 mm.

Geographical distribution. This butterfly is our most recent and least desirable importation and will doubtless, before many years, spread over the whole northern hemisphere; in the Old World it extends from the Atlantic to the Pacific in almost all localities between the 30th and 60th degrees of latitude; in Switzerland it is found from the plains to the level of perpetual snow. It was introduced into America, at Quebec, about 1860 and at New York in 1868. Its progress has been detailed above, in the last excursus, and is shown graphically upon a special map. Its occurrence on one occasion in midocean is recorded in *Psyche* (i: 152). There is no cultivated spot in New England where it is not found. It has even been taken on the barren subalpine heights of the White Mountains.

Oviposition. The eggs are laid erect in large numbers but not in contiguity, on the under surface of the leaves of cruciferous plants. In the case of the broad-leaved forms like the cabbage and turnip they are not laid on the ribs; but when the leaves are upright, they are often deposited on the upper surface, especially when, by the growth of the leaf, the upper sur-

face has become undermost ; occasionally also when they are fairly vertical. They hatch in a little more than a week.

Food plants. The caterpillar feeds principally on cabbage, but it also attacks cauliflower, another form of *Brassica oleracea*, and many other cruciferous plants, especially turnip (*Brassica napa*), horseradish (*Nasturtium armoracia*) and radish (*Raphanus*) ; it has also been found on mustard (*Sinapis*), gillyflower (*Matthiola*) and sweet Alyssum (*Alyssum maritimum*) according to Riley and others, all of which are introduced plants. But besides these it has been found on native cruciferae, such as *Nasturtium palustre* (Scudder), *Barbarea vulgaris* (Schwarz) and *Cakile americana* (Hamilton). Messrs. Bowles, Andrews and others have found it plentifully on mignonette, *Reseda odorata*, belonging to a neighboring family, and it has many times been reported both in this country and in Europe on *Tropaeolum*, one of the Geraniaceae ; but as the common name of this plant, *Nasturtium*, is the botanical name of one of the Cruciferae given above, this needs special verification. Specimens that I reared refused to eat a growing plant of shepherd's purse (*Capsella*). In Europe it has been found on the following genera of Cruciferae : *Brassica*, *Sinapis*, *Nasturtium*, *Hesperis*, *Matthiola*, *Cheiranthus*, *Erysimum*, *Lepidium* and *Raphanus*. Also, as with us, on *Reseda*, and, according to Riley, it has even been found on a species of *Salix* in England.

Habits of the caterpillar. The young caterpillar eats small patches in the parenchyma of the under side of the leaf, and, after feeding, the activity of the digestive organs can be seen by the rythmical motion of the clubbed hairs on the sides of the body. Later it feeds in exposed positions, usually on the under surface, and devours the whole leaf excepting the harder veins. When the plants are headed, it works its way up from below in disconnected passages, riddling the leaves in every direction and forcing itself towards, though rarely to, the very heart of the plant in search of the tenderest leaves ; its ravages are partially concealed by the nearly untouched outer leaves, and the ejectamenta falling through the numerous passages leave the immediate surroundings of the caterpillar comparatively clean. It is on account of this habit of boring into the heart of cabbages, says Riley, that the French Canadians call it the "ver du coeur" or heart-worm, though the true "ver du coeur" of Europe is the allied *Mamepalpa brassicae*, the caterpillar of which is of a more social nature, the eggs being laid in open clusters. The damage done by this caterpillar has been very great, especially in the first years after its introduction, before its parasites began to hold it in check. Mr. Greene of St. Alban's Bay, Vt., writes in 1869, "Last year I put out 3000 early cabbage plants ; about the first of September these worms made their appearance ; there would be from ten to fifty on a head and the result was they entirely destroyed the crop ; and not only mine but all throughout the country " The Abbé Provancher estimates

the damage done in a single year (1869) in the vicinity of Quebec at \$240,000, and Mr Ritchie states that one farmer near Montreal lost in a single season over 12,000 head of cabbages. In 1870, according to Mr. Angus, they destroyed the whole crop of cabbage and cauliflower in some places about New York where the insect had appeared only the year before, but parasites were seen the same season and in 1871 the butterflies were less abundant.

According to Forbes, the only insecticides to use with this insect which have any practical value are pyrethrum and kerosene, and these can be used in the field with good effect only before the plants have headed.

Pupation. In preparing for transformation the caterpillar spins a flooring of silk on the spot it has chosen, most frequently the under surface of some dead wood, like a fence paling, making it thickest at the point where the attachments of the chrysalis are to be. It fastens a girth around its body across the middle of the first abdominal segment, and so snugly that its body is usually closely appressed to the surface. It seems to prefer a surface as nearly horizontal as possible. The change to chrysalis takes place in about twenty-four hours after the work is completed, and after the change the girth is found crossing the same segment. The chrysalis, when not hanging for the winter, generally changes in about ten or twelve days.

Life history. This butterfly is triple-brooded in New England though only double-brooded in Europe. It is a little earlier than its congeners, appearing in the spring in Europe ten or twelve days before *P. napi*, and in America about a week or less before *P. oleracea*. In the latitude of Boston, the male appears shortly after the middle of April, sometimes not until the 24th or 25th, and both sexes are very abundant early in May and continue to fly for at least another month. By the second week in June they become scarce, and after the middle of the month few are seen. The butterflies pair not twelve hours out of chrysalis, and the eggs are laid through most of May and until the butterfly disappears; they hatch in eight days and the caterpillars require from two to three weeks to gain their full size. The chrysalis hangs from eight to fourteen days and the second brood of butterflies appears the last week of June; it continues to emerge from the chrysalis for fully a month and remains upon the wing until the third brood makes its appearance, which in its turn flies until nearly the middle of October; so that with the exception of a week or ten days in June, rarely prolonged to a fortnight, these butterflies are with us from early spring to the time of severe frost. Owing to this the time of the advent of the third brood is less marked, but its first members arrive in the latter half of August; caterpillars in nearly every stage and chrysalids may be found throughout August and September and almost to the end of October, when the last caterpillars transform to chrysalids and hibernate in this condition.

Behavior of the butterfly. The butterfly frequents gardens and meadows, hovering over and alighting upon flowers or dancing among the herbage; according to Mr. Lintner, it is specially attracted by the blossoms of burdock, *Lappa major* Gaertn. Its flight is rather feeble, "lumbering" Riley calls it, and so slow are the tremulous movements of the wings that one may often follow them with the eye; it usually flies but a short distance, from two to four feet, above the herbage. As Riley remarks, it is one of "the most assiduous of insects, continuing on the wing from early morning till late in the afternoon."

When the butterflies are resting for the night, the wings are at first erect but parted at about an angle of 20° , the front pair dropped back between the hind wings, so that the costal border of the latter conceals half of the upper median spot of the fore wings; the tongue is half unrolled; the antennae viewed from the side are slightly raised and curved; viewed from above they are slightly curved outward and spread at an angle of about 100° . Later the wings are a little more snugly folded. One found at dusk, head upward, at the tip of a grass-blade, had the wings closely packed, the costal border of the fore wings a trifle behind that of the hind pair and the antennae, spread at an angle of about 60° , drooped a little from the axis of the body, the club parallel to that axis.

According to Packard, the butterfly shows a partiality for white flowers. "On a September afternoon," he says, "I observed, in a field where a low, white aster and a common golden-rod (*Solidago*) were abundant, twelve European cabbage butterflies fly directly to the less conspicuous but white aster, and invariably pass by the yellow flowers of the golden-rod. On a following day, however, the white cabbage butterflies on the same spot were seen occasionally to visit the golden-rod, but with an evident partiality for the white asters." (*Am. nat.*, xi: 243.) According to Hart (*Nature*, viii: 244-245), this butterfly is an agent in the fertilization of violets.

The butterflies pair in a very short time after emerging from the chrysalis. I have had them pair in my room within twelve hours of eclosion; when paired, it is the male that flies or crawls, the female hanging motionless. I once observed a male attempting to mate late in the season (September 15) with a female *Eurymus philodice* which was alighted and which acted toward the male in every respect as toward a male of her own kind. The pair were by a travelled road and were unfortunately disturbed. Dr. Hoy records (*Can. ent.*, xiv: 99) a case where—again late in the season, October 10—a male of this species paired with a *Pontia protodice*, which afterwards laid eggs on a bunch of mustard, and the eggs hatched and reached their third stage, but finally all perished.

It should not fail of mention here, though already stated, that this butterfly may be said to have practically extirpated the native species, *P. oler-*

acea, in all places except in the hill regions, where cultivation is scarce. The reason for this is to be found in part, it seems to me, from the earlier appearance of the broods, the caterpillars of which thus get possession of all the best feeding places.

Dimorphism and variation. As mentioned in the descriptive portion, the early brood of this butterfly, from wintering chrysalids, differs from the later broods. The spring butterflies are smaller and of a duller white than the summer butterflies, with broader black markings on the middle and tip of the wing, and the base sprinkled with black atoms, which are almost entirely wanting in the summer butterflies; beneath, where the markings are most conspicuous and varied, there is a powdery streak of black scales along the middle of the hind wings of the spring butterflies, which is much less conspicuous in the later broods. These differences appear equally in Europe and America. Those wishing to investigate the variations of this butterfly geographically will do well to study the observations of Mayer (Stett. ent. zeit., xii: 151), Staudinger (Horae ent. ross., vii: 33) and Speyer (Stett. ent. zeit., xliii: 376).

These same seasonal distinctions also appear in the yellow variety *novangliae*, which was first observed in Canada by Bowles, and mentioned by him in his paper published in 1864. Although this variety doubtless occurs in Europe, as shown by Bowles's reference to Curtis's statement in his *Farm Insects*, afterwards repeated by Fernald (Can. ent., xv: 237), it is undoubtedly of excessive rarity, as it was unknown to Stainton and to Boisduval, neither of whom had seen it until I showed it to them; nor was it known to any of the French entomologists present at a meeting of the Paris society where I showed (Bull. soc. ent. Fr., Apr. 21, 1873) the specimen I afterwards gave to Boisduval, and which is now in Oberthür's collection. Nor have I seen any subsequent notice of such a form. With us it was estimated to have occurred about once in five hundred cases, which is by no means excessively rare in such a common insect, and half a dozen have been bred from one batch of larvae; but the interesting thing is that it is now excessively scarce; the free chance of multiplying and the new order of things which this insect found on its introduction to this country, seem to have given it a chance to develop this variety, merely potential in Europe; but now that parasites have come to the fore, the reaction from the disturbed order of nature has set in, and the creature is held in check as in Europe, with only occasional and local outbursts, the variety no longer appears except in instances which may bear comparison with the European. Possibly, however, it keeps company with the pioneers. The disappearance of this variety is as interesting as its apparition. I have not heard of it from further west than Michigan, and the last specimen seen by me on the wing in New England was in 1878.

Miscellaneous. The male of this species has a very faint but pleasant odor, difficult to detect. I have sometimes done so, but at other times have been unable to perceive it, on rubbing the scales of the upper surface of the wings and immediately smelling the fingers. It comes from the scattered androconia.

Dr. Dimmock tried some experiments (*Psyche*, ii: 21) with the imago of this insect, to see how it would endure breathing certain gases. Exposed for periods varying from one to thirty minutes in an atmosphere of carbonic monoxide, motion ceased in from eight seconds to a minute, was resumed again in from ten seconds to five minutes after removal, and became active in from twenty seconds to three minutes thereafter. The sex, which may account for the differences, was not noted. "They all rubbed their probosces about their legs while recovering, and several . . . exhibited a slight tendency toward paralysis of the posterior limbs during recovery." Immersed in hydrogen, the butterfly was rendered motionless in half a minute, and remaining five minutes in the gas, began to move at the end of eight minutes after removal, and to fly "in a weak manner" in two more minutes. One placed in a mixture of eighty parts of hydrogen and twenty of oxygen, and one in equal parts of each showed no signs of weakness at the end of half an hour.

Mr. Davis pierced some chrysalids of this species with pins, but they hatched, nevertheless, one of them emerging with the pin through its thorax, as if impaled for the cabinet. Many other species, however, exhibit similar tenacity of life.

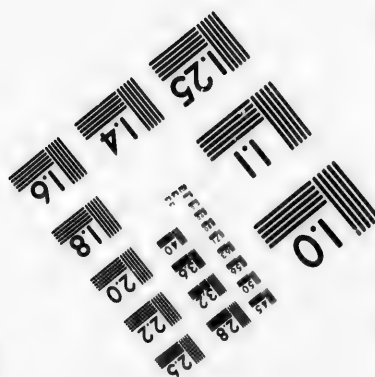
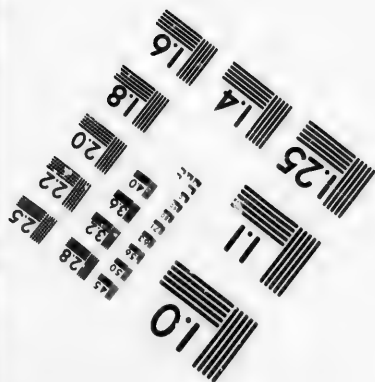
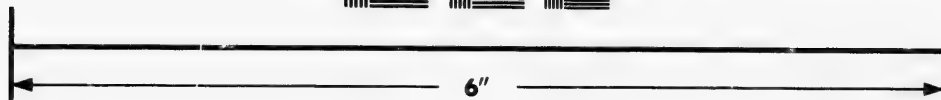
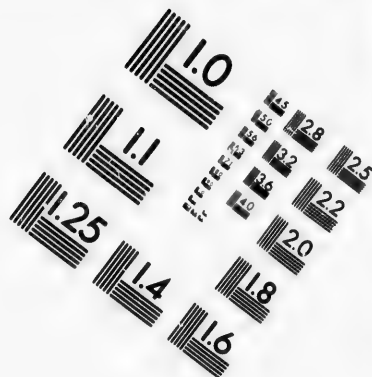
Parasites. An account of the insect enemies of this destructive butterfly may well begin with Europe, where the pest originated. The insect is there attacked by vast numbers of *Apanteles glomeratus*, which issue from the body of the larva, form their cocoons by its side, and emerge as flies in eight or nine days; of these, in my experience, about two-thirds are females; about four days later some of the cocoons will yield another hymenopterous, *Mesochorus splendidulus*, a parasite of the parasitic *Apanteles*, and larger than it. Mr. Howard has given me a list of other parasites, among which is another species of *Apanteles*, *A. rubecula*, a solitary parasite on the larva not half grown; *Pteromalus puparum*, which is one of its chief enemies, and which issues from the chrysalis when it has undergone all its transformations within the body of its host; the males are generally many times more numerous than the females; two species of *Monodontomerus*, *M. aerus* and *M. dentipes*; and finally the other hyperparasites, *Mesochorus aciculatus* and *Hemiteles fulvipes*. Kaltenbach says that *A. glomeratus* is attacked by *Diplolepis microgastri*. Among dipterous parasites, Dr. Williston finds recorded two species of *Phorocera*, *P. concinnata* and *P. pusilla*, the former of which I have myself raised there (specimens determined by Loew); and *Exorista vulgaris*, the last of

which makes its escape from its host, sometimes before, sometimes after, the change to chrysalis.

A few words may be added regarding *Pteromalus puparum*, of which I have reared and counted over two thousand specimens in Europe, in order to determine the proportion of the sexes. Hyperparasitism is very common, but from nineteen chrysalids attacked by this parasite alone, 481 males and 677 females were obtained, the number varying from 22 to 132 specimens and averaging 61 for each chrysalis; the chrysalids were always broken open to include in the count those that did not hatch. These all emerged between February 7 and May 1 at Mentone in southern France. In some instances the entire brood would emerge in a single day; at others the bulk would emerge the first day and others would straggle out one after another for a week or more; sometimes again they would come out daily or almost daily for several weeks, as in one instance from February 24 to March 14; in another, the most extended, from March 18 to April 28. Males and females seem to be equally early and late. In almost all cases where the total number was very great, the males exceeded the females; while when the number was small the females were many times more numerous than the males; as a whole the females averaged a little over 35 to a little over 25 males, and in only one-third the instances where the number of the females fell below the average, the males outnumbered them; the most excessive case was 84 males and 12 females, or 7 to 1. The greatest relative excess of females over males was 36 females to 2 males, or 18 to 1. One thing that struck me as curious was the much greater activity of the females; the specimens were killed by the fumes of a sulphur match under an inverted tumbler, and before dying a far greater proportion of females than of males would leap out of the box in which they had hatched to die on the floor outside. Those inside and outside were separately counted in many instances; this may serve as an example: outside, 5 males, 30 females; inside, 11 males, 4 females. When they first emerge from the chrysalis they make little flying leaps of about three centimeters, but not often in quick succession; if they chance, as not infrequently, to fall on their backs, they curl up the legs and remain motionless; they are on the whole sluggish, and permit themselves to be seized with the forceps while resting on the butterfly chrysalis from which they have emerged; and will then cling with such tenacity that I have moved the chrysalis in forcibly removing them.

In this country the hymenopterous parasites so far known are only two in number, both of them identical with European species and the most efficacious of them, namely, *Pteromalus puparum* (89:1-2) and *Apanteles glomeratus* (88:12). The former of these was first noticed at work in 1869 by Mr. Ritchie of Montreal, and reared by him from the chrysalis in the following year; but there are specimens in the British Museum taken





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in the Hudson Bay region in 1844. The year after Mr. Ritchie, others reared the same parasite from *P. rapae*, and one of the first accounts published was one by Master Sprague, then only ten years old, I believe :—

I was looking for some chrysalids for my father, when I saw a little fly walking all over them; by-and-by it made a little hole in the chrysalis to lay its eggs in. The fly is almost one-eighth of an inch long; it is of a golden color. Some of the flies have yellow legs, and others have dark ones. They have four wings; the body is pointed at the end; there are about fifty of these flies in a chrysalis; the chrysalis looks as if it were all right, but if you break it open you will find it full of little grubs. (Can. ent., iii: 235.)

Some years later we have the following account of the operations of this insect, by a well known observer :—

A few days since, while watching some of the full grown larvae of the cabbage butterfly, which were feeding on *Nasturtium* leaves, I was much gratified in witnessing the method of attack which this parasite adopts. Settling herself quietly down on the back of the caterpillar, near the terminal segments, with her head towards the caterpillar's head, she paused awhile; then with a sudden movement of her ovipositor, so quickly that the motion almost escaped detection, she thrust an egg under the skin of her victim. The caterpillar seemed startled, and quivering, jerked its head and anterior segments suddenly about, and then quieted again; the little tormentor meanwhile sitting perfectly composed on the spot where she first settled. Presently another thrust was made, followed by further uneasy movements of the larva, and in this manner, in the course of a very few minutes, quite a number of eggs were deposited. The caterpillar did not seem to be conscious of the cause of its troubles, nor, indeed, of the presence of its enemy, excepting when the thrusts with the ovipositor were made. On drawing a little nearer for the purpose of better observing this interesting operation, the tiny creature took alarm and flew off. Further examination revealed the presence of several more of these little friends, busily searching for further specimens to operate on. (Saunders, Can. ent., x: 185-186.)

The earlier stages of this parasite are figured by Dr. A. S. Packard in his second Report on the Insects of Massachusetts, and he gives the following description :—

The larva is a little white maggot about a sixth (.17) of an inch in length. The body consists of thirteen segments, exclusive of the head, and is cylindrical, tapering rapidly towards the head, while the end of the body is acutely pointed. The chrysalis is whitish, the limbs being folded along the under side of the body, the antennae reaching to the end of the wings; the second pair of legs reaching half way between the end of the wings and end of abdomen; while the tips of the third pair of feet reach half way between the second pair of feet and the end of the abdomen. It is from a line to a line and a third in length.

The chrysalids of *rapae* that are infested by them are readily distinguished by the livid appearance of the body, and in the period of greatest abundance of the insect fully two-thirds are found thus attacked. As we have seen, more than a hundred eggs may be deposited in a single caterpillar without preventing its reaching the chrysalis stage; and as these may be laid at different times, the parasites may be found in newly formed chrysalids in various stages of growth. Within the chrysalis the parasite winters, and as

there is more than one brood annually, the check on the spread of rapae must be of untold importance to the farmer.

Before this insect was recognized as identical in the two worlds, Mr. Otto Lügger introduced European specimens into the region about Baltimore by bringing with him three plates of the infested chrysalids from Germany.

The other European species, *Apanteles glomeratus*, was first reared by myself in Cambridge, Mass., within a year of the arrival of *P. rapae* at that point, as it was before I left for Europe in June, 1870. At first it was described as a distinct species; it has now been found as far west as Michigan, and it may be questioned if it too be not indigenous. Hymenopterous parasites of some kind have also been found as far south as Georgia, and as early as 1876 (Oemler).

The only other hymenopterous parasites known in this country are hyperparasitic; one, *Mesochorus pieridicola*, like the *Mesochorus* attacking *Apanteles* in Europe, larger than its host; the other a *Tetrastichus*, reared by Mr. Riley.

But we have our dipterous parasite also; it was recognized first in Quebec by the Abbé Provancher, and since by many others. It is an *Exorista* and was described by Osten Sacken under the specific name *hirsuta* (89:13-15). I had one maggot come out from a chrysalis at the end of June and give birth to the fly after ten days. Dr. Williston thinks this fly may be identical with one of the European parasites of rapae, in which case all of our direct parasites are the same as the European and fewer in number.

We have also our spiders which devour the young caterpillars, according to Fitch, and Barnard and others have found the gluttonous Hemiptera, *Phymata crosa* and *Arma spinosa*, impaling them while still small.

Finally it is highly probable that wasps are as detrimental here to the life of this butterfly as in England, where Newport long ago observed the attacks of *Vespa vulgaris* and gave the following graphic account:—

"I observed, on a sudden, a specimen of *P. rapae*, towards which I was then looking, precipitated to the ground from the thistle-blossom upon which it had been very quietly seated; and upon going up to it immediately, I found a wasp very busily employed in cutting off its wings and head, and afterwards its legs. When it had done this it took up the dismembered body, and poising it between its own legs, flew away with it to a neighboring tree, where, upon following it, I found it mangling the body of its prey, as if to destroy the little remaining vitality. While doing this the wasp had suspended himself upon a leaf by the claw of one leg, which supported its whole weight, while its other limbs were employed in holding and turning the mangled body of the butterfly. When it had done this sufficiently the wasp rolled up the body between its second and third pairs of legs, and poising itself upon its wings, flew away towards its nest. . . . Its chief prey among lepidopterous insects is *P. rapae*, although it attacks all the other species of white butterflies. I saw it attempt to capture the fine species, *Vanessa atalanta*, but the insect was too nimble for it. If it misses its object it does not make a second attack, but flies on to the next thistle. (Trans. ent. soc. Lond., 1: 228-230.)

Desiderata. No one has attempted as yet to trace the limits within which this species is digoneutic, as it appears to be throughout Europe. Probably it is so in the White Mountain region of New England and in the more northern limits of its range; southwardly it probably becomes polygoneutic and the separation of the broods would be difficult. It might, however, be possible to trace the southern limits of trigoneutism. The forward march of the species in the extreme south and west merits immediate attention and the rapidity with which its parasites find it out. The variety *novangliae* invites close study; every instance of its occurrence (and abundance) should be noted, giving date and place, and, when known, the food plant of the caterpillar which produced it. Is it now found at all commonly in regions invaded by *R. rapae* within five years? Does the caterpillar feed of its own choice on *Tropaeolum*, and if not will hunger induce it to do so? Do any of our native parasites, not also found in Europe, attack the caterpillar, or the egg?

LIST OF ILLUSTRATIONS.—*PIERIS RAPAE*.*Egg.*

- Pl. 65, fig. 28. Plain.
68: 16, 17. Micropyle.

Caterpillar.

- Pl. 72, fig. 4. Caterpillar at birth.
76: 11, 12. Full grown caterpillar.
79: 53. Head, fifth stage.
86: 31. Prolegs
86. Glandular swelling of first thoracic segment.
43. Dermal appendage, first stage.

Chrysalis.

- Pl. 84, fig. 58. Side view.
65. Dorsal view.

Imago.

- Pl. 7, fig. 11. *P. r. novangliae*, ♂, both surfaces.
12. *P. r. rapae*, ♂, both surfaces.
16: 4. Female, upper surface.
5. Male, upper surface.
35: 10. Male abdominal appendages.
46: 40. Androconium.
61: 62. Papilla of tongue.

General.

- Pl. 88, fig. 12. *Apanteles glomeratus*, a parasite.
89: 1-2. *Pteromalus ouparum*, a parasite.
13-15. *Exorista hirsuta*, a dipterous parasite.
Map of distribution in North America from 1860 to 1886.

SUBFAMILY PAPILIONINAE.

SWALLOW-TAILS.

Equites Linn.; Equitides Herr.-Schneff.;	Dup.; Papilionidi Steph.; Papilioninae
Equitina Herr.-Schneff.	Bates.
Archon'es Hübn'r.	Nobilis Gravenhorst.
Papilionae Swains.; Papilionides Boisd.;	Tentaculatae Guenée.
Papilionites Blanch.-Brullé; Papilionidae	

La pauvre fleur disait au papillon céleste :

"Ne fuis pas !

Vois comme nos destins sont différents. Je reste,

Tu t'en vas !

"Pourtant nous nous aimons, nous vivons sans les hommes

Et loin d'eux,

Et nous nous ressemblons, et l'on dit que nous sommes

Fleurs tous deux !

"Mais hélas ! l'air t'emporte et la terre m'enchaîne.

Sort cruel !

Je voudrais embaumer ton vol de mon haleine

Dans le ciel !

"Mais non, tu vas trop loin ! Parmi des fleurs sans nombre

Vous fuyez,

Et moi je reste seule à voir tourner mon ombre

A mes pieds !

"Tu fuis, puis tu reviens, puis tu t'en vas encore

Luire ailleurs.

Aussi me trouves-tu toujours à chaque aurore

Toute en pleurs !

"Oh ! pour que notre amour coule des jours fidèles,

O mon roi,

Prends comme moi racine, ou donne moi des ailes

Comme à toi !"

VICTOR HUGO.—*La Pauvre Fleur.*

Imago. Butterflies of large size. Head large. Front a little tumid, usually most so below; occiput with a broad, tumid, transverse, curving ridge; antennae rather stout, naked, more or less sinuous vertically, as long as or a little longer than the abdomen, consisting of from thirty-four to forty-four joints, the club distinct, usually considerably arcuate, compressed, its increment added to the inner side only, occupying from one-fourth to one-sixth of the whole antenna. Palpi minute, reaching only the middle of the front of the eye, the clothing compressed in a vertical plane.

Prothoracic lobes lamellate. Thorax rather stout, not compressed; middle of front of mesoscutellum projecting far between the mesoscuta so as to be mostly included between them, the lateral portions being but slender projections; metascutellum thickened above, forming a small, quadrate mass between the metascuta but mostly vertical; metascuta small but little tumid.

Fore wings broad, usually subfalcate, the outer border nearly straight. Costal nerve terminating not far from the middle of the outer half of the costal border; subcostal nerve with four superior, simple branches of which two usually arise before the tip of the cell and two beyond it, the third sometimes at it; in the outer half of the wing the first three superior nervules all run parallel to, and at equal distances from one another, crowded close to the costal margin and thus presenting an effect similar to what is seen in Hesperidae; discoidal cell broad, fully half the length of the wing; median nerve with four branches, the first arising at about the middle of

the cell; in all our native species (and in all of those not resembling the Pierinae) connected at the base to the submedian nervure by a short cross vein; internal nervure connected with the submedian nervure at the base and running toward the inner border. Hind wings rounded, the outer border usually crenate, (in the species which do not resemble the Pierinae—such as *Parnassius*—usually) in our New England species always with the last median nervule prolonged into a broad and long tail; the same is occasionally true of some of the other nervules. Costal nervure terminating at the apex of the wing, emitting upward near the base a short and stout, usually curving or Y-shaped shoot; frequently united, just beyond this, to the subcostal nervure by a strongly oblique cross vein directed toward the base; subcostal nervure united to the median by a stout branch, as short as and sometimes shorter than its neighbors, and attached nearer the second divarication of the median than of the subcostal, directed a little inward in passing from the subcostal to the median nervure; first median nervule arising some distance beyond the middle of the cell; internal nervure wanting; inner margin narrowly plaited and not forming a gutter for the reception of the abdomen.

Legs very long, the hinder pair usually a little longer than the middle; tibiae bare of scales or provided scantily with them; fore tibiae with a leaf-like appendage near the middle of the inner side; tarsi furnished above with four, below with two rows of spines; claws long, but little curved, simple; paronychii wanting.

Abdominal appendages of the male with the upper organ very inconspicuous, the centrum apparently obsolete, the hooks double, consisting of a pair of disconnected, corrugated or subspiral ribbons at the base of the intromittent organ. Clasps with the edges always smooth and those of opposite sides attingent, their inner surfaces furnished with a conspicuous, more or less curving, prickly ridge.

Egg. Nearly spherical, the sides arched more strongly than the summit, the base flattened for attachment; surface with no external ornamentation beyond a slight rugosity, but the substance of the shell reticulate; there is only slight variety of form among the genera.*

Caterpillar at birth. Head with no posteriorly descending surface above, where it is partially enwrapped at rest by a fold of the first thoracic segment. Body more or less angulated at the lateral line instead of being nearly cylindrical as at maturity; the segments furnished with several rows of distinct, bristle-bearing tubercles, one to a segment in each row, those at the extremities of the body often larger and longer than those in the middle, and frequently compound to a high degree, bearing many diverging bristles.

Mature caterpillar. Head considerably smaller than the first thoracic segment, partially covered or hooded by the folds of tegument of the first thoracic segment. Body cylindrical, usually largest and sometimes considerably so near the anterior end, tapering slightly toward the head and considerably backward; the first thoracic segment furnished upon the dorsum with a Y-shaped osmaterium, a fleshy, highly colored scent organ of nearly uniform thickness throughout, completely retractile when not in use. Body almost entirely naked, sometimes furnished with long, fleshy filaments, but otherwise only with smooth, hairless, lenticular, scarcely raised disks or with very minute papillae bearing very minute hairs irregularly distributed. Body marked with patches or transverse streaks of color, or by a diverse coloring for different longitudinal regions of the body.

Chrysalis. Head with a pair of anterior, lateral, more or less pyramidal prominences—the ocellar protuberances. Dorsal surface of the abdomen ridged, if at all, along the laterodorsal line; posterior edge of the wings forming on the two sides about a right angle with each other. Under surface swollen in the middle of the wings; lateral ridge including the upper edge of the wings. The anterior half of the body

*One tribe, *Parnassidi*, not found in America east of the Rocky Mountains, has an egg of a different type, the form being more

oblate with a distinct reticulation over the whole surface, giving it a pitted appearance.

bent backward at a greater or less angle with the posterior half. Mesothorax with a central, elevated, posteriorly appressed prominence. Tongue reaching the tip of the wings; antennae falling considerably short of them. The girt passes across the middle of the metathorax.

Distribution and general characteristics. This subfamily is almost as widely spread as the Pierinae, and, with the exception of a few genera is also decidedly tropical. "South America, North India and the Malay Islands are the regions where these fine insects occur in the greatest profusion and where they actually become a not unimportant feature in the scenery" (Wallace, Nat. selection, 140). One genus, however, *Parnassius*, is found only at high elevations in the temperate zone. Among the tropical genera probably none are common to the Old and New Worlds, but nearly all the others are found in both though only one or two species are believed to be identical; the Old World is somewhat richer in generic and specific types.

The butterflies are almost always large and as a rule conform to a single type, long and unfortunately still known under the name of "Papilio," in which group the hind wings of most of the species are provided with long, slender, tail-like extensions of one or more of the median nervules, which has gained for them the popular name of "swallow-tails." With the exception of a few genera which resemble the Pierinae in their black markings on a pale (white or yellow) ground, most of the butterflies are black, the hind wings and sometimes the fore wings provided above with large, submarginal spots of various colors, generally more variegated at the anal angle; beneath, the hind wings are often still more gaily painted with large lunules and patches of bright metallic tints of purple, blue and green. Wallace writes of the giant East Indian Ornithopterae, they "may be frequently seen about the borders of the cultivated and forest districts, their large size, stately flight and gorgeous colouring rendering them even more conspicuous than the generality of birds." (Nat. selection, 140.) And Hooker in his Himalayan journals speaks enthusiastically of the butterflies of this group in the tropics: "By far the most striking feature," says he, "consisted in the amazing quantity of superb butterflies, large, tropical swallow-tails, black, with scarlet or yellow eyes on their wings. They were seen everywhere sailing majestically through the still, hot air, or fluttering from one scorching rock to another, and especially loving to settle on the damp sand of the river edge; where they sat by thousands, with erect wings, balancing themselves with a rocking motion, as their heavy sails inclined themselves to one side or the other; resembling a crowded fleet of yachts on a calm day." This habit of assembling is shown in none of our species so strongly as in *Jasoniades glaucus*, instances of which will be given further on.

The relative position of this group has already been discussed under the

family. It may at once be distinguished from all butterflies hitherto treated by the four branches of the median nervure in the fore wing, and the foliate epiphysis of the fore tibiae. They are further separated from the Pierinae in particular by the unsplit claws, the absence of paronychii, and by the character of the inner border of the hind wings, which is sometimes folded back upon itself and encloses delicate, downy hairs, reminding one of the costal fold on the fore wings of *Hesperidi*; the outer border of the same wings is almost universally crenate, besides possessing the tails already mentioned. The fore wings are nearly always more or less falcate and are long in proportion to their width. With few exceptions the palpi are excessively short, reaching only halfway up the eyes. The organ forming in the males the dorsal element of the ninth abdominal segment is reduced to a mere corneous strip and its office entirely supplanted by the upper part of the eighth segment which is proloaged backward in the form of a hook. The females of a few genera are provided with a very extraordinary corneous pouch or alate expansion on the under surface of the abdomen whose function is not yet fully known, although it is probably connected with oviposition*. The butterflies are insects of strong but irregular flight, often ascending high in the air and sailing in long, sweeping curves.

There are certain features in the *Papilioninae*, generally of no great importance, which continually remind one of the much higher group *Euplocinae*. They are each dominant types; the caterpillars are stout and fleshy, each often with fleshy filaments; the antennae are naked and have a somewhat similar curve, the palpi are short, the legs long and compactly scaled, the thorax and body very often similarly and rather peculiarly spotted; and even the abdominal appendages of the male *Parnassius* have some curious elements in common with that of *Anosia*.

The insects of this group are generally at least double-brooded and winter as chrysalids. The exceptions are as usual in the group of *Parnassidi* which are probably all single brooded, and are supposed to winter in the egg. According to Gentry, hawks among birds are the special foes of the butterfly.

"M. Duponchel has published a notice relative to the genus *Thais*, some individuals of which remained two seasons in the chrysalis state, being the only instance on record of such an occurrence amongst the butterflies." (Westwood, *Classif. ins.*, ii:349.) Boll mentions a similar case in *Heraclides cresphontes*, and Morris in *Papilio polyxenes*.

Haase (*Zeitschr. f. ent.*, n. f., x:42) regards this group as of high antiquity on account of its wide distribution coupled with the similarity of neururation throughout the group.

A very perfectly preserved fossil butterfly belonging to this group,

*See Elwes, *Proc. zool. soc. Lond.*, 1886, 8-14, for the latest observations.

Thaites ruminiana, has been found in the tertiaries of Aix in southern France.

The early stages. The eggs of the swallow tails are always subspherical and nearly destitute of sculpturing, resembling the Pamphilidi, or certain Sphingidae, but those of the Parnassidi are covered with minute pits, and thus strikingly similar in surface sculpture to the eggs of *Lycaenidae*; and not improbably still different forms of eggs may be found in other genera.

The juvenile caterpillars of the swallow-tails are peculiar for the long bristles arranged on fleshy tubercles, many of the latter compound, and larger at the extremities of the body than in the middle. Those of the Parnassidi are described below. The mature caterpillars of all the subfamily look very differently and may be distinguished by the possession of osmateria, — a strongly scented, bright colored, viscid, forked tentacle which is wholly concealed at ordinary times but is suddenly extruded if the animal be offended or alarmed.

When we consider [says Wallace (Nat. selection, 135)] this singular apparatus, which in some species is nearly half an inch long, the arrangement of muscles for its protrusion and retraction, its perfect concealment during repose, its blood-red color, and the suddenness with which it can be thrown out, we must, I think, be led to the conclusion that it serves as a protection to the larva, by startling and frightening away some enemy when about to seize it, and is thus one of the causes which has led to the wide extension and maintained the permanence of this now dominant group. Those who believe that such peculiar structures can only have arisen by very minute, successive variations, each one advantageous to its possessor, must see, in the possession of such an organ by one group, and its complete absence in every other, a proof of a very ancient origin and of very long continued modification.

It should be remembered that according to Boisduval (Nouv. ann. mus., 1833, 261) the larva of one of the *Phalaenidae*, *Urania*, "fait sortir à volonté deux cornes rétractiles roses, placées sur le premier anneau." An argument of this kind which will apply to one will apply to the other.

According to Westwood, the osmateria of *Ornithoptera* are "contained in a fixed bifid sheath," but this statement requires corroboration, for it is founded upon Horsfield's illustrations, which may perfectly well be otherwise interpreted.

The caterpillars are naked, or armed only with fleshy prominences or filaments, and are generally brightly colored, often provided with a few large, eye-like spots, or streaked with patches of oddly mingled colors, giving them a grotesque appearance; the anterior segments of the body are enlarged in some species, while in others the whole body is equal; the head is partially covered by the first thoracic segment. Their habits are usually solitary, but in one South American group the caterpillars live on *Aurantiaceae*, in societies of one or two hundred individuals, and when young, feed side by side in rows, and the caterpillars of one of our New England genera are social during at least a part of their life; excepting a

few, which devour umbelliferous plants, all the known larvae live on trees or shrubs, though of very different groups.

With the exception of some of the Parnassidi, which resemble the Pierids, the chrysalids are always more or less angular and generally rugose, the ocellar region advanced to form a bifid front, as in the Nymphalidae; like the Pierinae, they are suspended by the tail and a loose girt about the middle, and some of the group of Parnassidi are also enclosed in a cocoon of leaves loosely fastened together. Harris gives (*Ins. Inj. veg.*, 264) the following description of the pupation of our native species:—

It first spins a little web or tuft of silk against the surface whereon it is resting, and entangles the hooks of its hindmost feet in it, so as to fix them securely to the spot; it then proceeds to make a loop or girth of many silken threads, bent into the form of the letter U, the ends of which are fastened to the surface on which it rests, on each side of the middle of its body; and under this, when finished, it passes its head and gradually works the loop over its back, so as to support the body and prevent it from falling downwards.

The division of the subfamily. Although only one of the two principal subdivisions of this subfamily occurs in our fauna and is treated of in this work, it may be worth while to point out one or two of the distinctions between them, as I have here and there intimated that such tribal distinctions exist, though they have only been rarely and partially recognized by systematists. The two tribes to which I refer are the Parnassidi and the Papilionidi, the latter only of which is found in eastern America. To the former belong all those genera of Doubleday and Westwood's work which follow their magazine genus *Papilio*. They differ from the Papilionidi more particularly in the structure of the earlier stages, some of the genera being related to the Papilionidi in certain particulars much more closely than are others. In general, they may be said to stand between the Pierinae on the one side and the Papilionidi on the other. The ordinarily rounded form of their wings shows their alliance to the Pierinae, while the uniform neuration of the wings themselves shows that they cannot be separated widely from the Papilionidi. With the latter they share the foliaceous appendage of the fore tibiae, the four-branched median nervure of the fore wing, the excavated inner margin of the hind wing, the comparatively robust body, the more or less arcuate antennae, and the absence of paronychii and pulvillus.

So far as I have been able to see their earlier stages, which, excepting for the mature caterpillar and chrysalis, is certainly to a very limited extent, these tell the same story. The egg of Parnassius, the only genus I have seen, and which, as well as the earliest stages of the caterpillar, I know only through specimens recently sent me by Mr. Edwards,* is in no proper sense tiarate, but has a form more closely resembling that of the Papilionidi, for they are broadly truncate and not greatly contracted

*Statements made early in this work are in part erroneous, from distorted material.

at the base, and, though considerably broader than high, are well domed above, with a considerable micropyllic infundibuliform depression; indeed, but for their larger basal contraction, their form is that of many *Heperidae*; the surface sculpture is certainly much like that of the *Lycanidae*, but the form of the egg is very different, and the sculpture differs no more widely from that of the eggs of the *Papilionidi*, than do the eggs of *Fenisea* from those of *Strymon*. The surface may best be described as deeply and profusely punctate, the cells being exceedingly numerous, with high walls, differing from the *Papilionidi* only in the extreme depth of the reticulation, this being almost invisible in the eggs of the latter tribe.

The young caterpillar (*Parnassius* only examined) shows a close relationship to the *Papilionidi* in being provided with longitudinal series of long bristles, longer than the segments, of which some at least are *clustered* on ranged tubercles; the bristles differ, however, in being spiculiferous, and in that there is no apparent expansion at tip; but the decidedly truncate form of the apex leads one to believe that they must subserve the same purpose, as an outlet of basal glands. The opening for the osmateria is shown at this early stage, and there is also on the mediodorsal line, in the incisure between the second and third thoracic segments, a minute, transversely oval opening, probably the outlet of some special gland, which has I believe never been noticed, and which is not found at maturity. In form, the relation of the head to the body, the structure of the head itself, and especially of the antennae, we have a precise counterpart of the young *papilionid* larva, but the length of the legs, both thoracic and abdominal, rather recall the *Pierinae*. There are no ranged series of lenticles or crateriform disks, unless possibly there is to be referred to this a single series of excessively minute spots, one to a segment, behind and a little below the spiracles. The mature caterpillar is distinctly related to that of the *Papilionidi* by the presence of osmateria; the structure of the head is, however, more like that of the *Pierinae*, though standing somewhat midway between these and the *Papilionidi*; there appears to be scarcely any descending surface on the posterior side, yet the summit is broad and in some instances a little arched.

The chrysalis differs from that of both the *Papilionidi* and the *Pierinae* in the lack of any frontal prominence, so that it cannot be distinguished as unimucronate or bimucronate; the peculiar structure of the genus *Thais* at its anterior extremity has elsewhere been entered upon. As a general rule the chrysalids are compact and well rounded, but there is considerable variety in this respect, some, like *Luehdorfia*, more nearly resembling in form genera of *Pierinae*, while others, like *Thais*, remind us more strongly of *Jasoniades* and *Papilio*. The surface-structure is marked in many instances by rugosities which take on a longitudinal form, as in the many genera of the *Papilionidi*. The wing tubercles are well pronounced and there is gene-

rally a distinct mesonotal tubercle or prominence of some sort. The mode of support is like that of the other members of the family, with the exception already alluded to of the anomalous mode of pupation of *Thais* and the other instances, *Doritis* and *Parnassius*, where the chrysalis is confined in a cocoon, and it is not clear from what has been stated, in precisely what manner the body of the chrysalis itself is supported. To judge, however, from specimens received from Dr. Staudinger, it would appear that they find no support beyond the cocoon itself, since there is no sign of cremastral hooks; and though the middle of the mesonotum, at least in *Doritis*, has a slight, transverse depression such as a girth might make at this point while the body was still soft, there is no mark whatever at the appropriate place on the ridge which follows down the wing from the basal wing tubercle; and in none is there any real mark of the thread itself.

It has lately been suggested by Mr. W. H. Edwards, without offering, however, any reason for his position, that *Parnassius* should be removed to the neighborhood of the *Lycaenidae*. This opinion would seem to be formed largely by regarding the structure of the egg, which certainly bears a certain resemblance to those of that group. But not a single additional point can be brought forward. Even the form of the egg does not agree; and a different story is told by the structure of the caterpillar at birth, including the form of the head, its clothing of hairs to the top, the mere thread-like ring which forms the second antennal joint, the excessive brevity of the third antennal joint, the clothing of the body with bristles not greatly longer than the segments, their apparently hollow nature, their clustering on ranged tubercles, the absence of distinct series of crateriform disks, the long legs, both thoracic and abdominal, and the low position of the eighth abdominal spiracle, not to mention the osmateria which are present here as in the mature larva. The same is the case without question in the mature caterpillar which one finds it hard to separate by any common characteristics from that of the *Papilionidi* and which in no single characteristic of its structure resembles the *Lycaenidae*. Precisely the same may be said of the chrysalis, with the single exception as far as I know of the genus *Doritis*, where in the rounded compact form with its few abrupt elevations, one sees a certain resemblance to the *Lycaenidae*, a resemblance which is heightened by the abrupt falling of the curve in front and behind, which causes the head to face almost completely forward and the last segment almost completely backward. But the intimate relation of this genus to *Luehdorfia*, in which none of these characteristics are found, renders such a view of its affinities impossible. Moreover, the structure of the prothoracic stigmata is distinctly that of the remaining members of the group and not at all that of the *Lycaenidae*.

Generic divisions. As has been stated, the bulk of the species of this subfamily have been placed by authors in a single magazine genus,

Papilio. Most entomologists would so class all the species contained in the present work. Besides the inertia of prejudice and tradition to be overcome, there is no longer any excuse for such a course. The few commonly accepted genera of Papilioninae have up to the present time been established not only almost entirely upon characters drawn from the perfect insect, but even upon a very narrow selection of these. The neuration of the wings has been employed nearly to the exclusion of everything else. Even the Felders, who attempted to separate the subfamily into clearly defined groups, hardly employed any other characters. Now it so happens that the neuration is remarkably uniform throughout the group, in striking distinction from the condition among their near allies, the Pierinae; but in the relative length of the tibiae to the femora and tarsi,—characters absolutely neglected—and in other features of the leg structure, we find differences even in the imago which are very striking and intrinsically far more important. While if we examine the early stages, excepting the egg (which is exceptionally uniform, as it is in the Pamphilidi) we discover many striking differences; there is indeed so great a variety among the caterpillars, particularly when mature, that the differences between the caterpillars of the genera of Pierinae or of those even of the Nymphalidae are insignificant beside them. Quite the same is true of the chrysalis, and we must conclude that the reason for the retention of the generic term *Papilio* to cover such a vast variety of form and structure is due simply to the fact that systematic naturalists have hitherto depended almost entirely upon characters drawn from the perfect insects; when they have mentioned the earlier stages it has only been in broad terms which implied no critical study whatever of their structure. Such a limitation is no longer justified. We invite attention to the tables and the descriptions which follow, and ask any student to compare, for instance, the caterpillars and chrysalids on the one hand of *Vanessa* with those of *Argynnis* (using these terms with the very widest latitude) and on the other hand of *Laertias* with those of *Iphiclides*, and either of these with *Heraclides* (using these in the narrow sense in which they are employed in this work) and if he can find *as good* grounds for separating the first two from each other as he can the last three, I should be glad to have them stated. If he cannot, and refuses to recognize these facts by the use of terms having as high a taxonomic meaning in the latter case as in the former, then he is yielding to prejudice, or to tradition, or to indolence, and is helping to perpetuate a false view of nature. The transformations of the principal genera, it should be added, are now as well known and as accessible among the Papilioninae as among the Nymphalinae. No excuse is needed for following in the present work the same taxonomic principles in both the groups; those who slavishly follow the ignorance of their fathers should be the apologists.

Table of genera of Papilioninae, based on the egg.

- Egg more or less beameared with a secretion on laying.
 Egg heavily beameared, laid in small clusters, the height and width of the egg equal, notwithstanding the truncate base.....**Laertias.**
 Egg lightly beameared, laid singly, the form perfectly globular but for the considerably truncate base.....**Heracilides.**
 Egg with no perceptible adventitious covering, laid singly.
 Egg distinctly broader than high.
 Cells of the tracery with granular raised points.....**Jasoniades.**
 Cells of the tracery smooth or nearly so.....**Euphoeades.**
 Egg barely broader than high.....**Papilio.**
 (Iphicilides not examined.)

Table of genera, based on the caterpillar at birth.

- No simple papillae bearing a single bristle arranged upon the dorsum in subdorsal series, in any striking contrast to the others from their smaller size.
 All abdominal papillae above the spiracles bearing single and simple bristles.....**Laertias.**
 Most of the abdominal papillae above the spiracles compound, bearing many bristles many of which are distinctly forked apically.....**Iphicilides.**
 A subdorsal series of simple papillae, each bearing a single bristle, strikingly different in size and simplicity from the compound tubercles of the adjacent rows.
 Bristles of the supralateral or lateral series three or four in number and, as well as the tubercles themselves, sensibly diminishing in importance toward the middle from either end of the body; bristles of the supra- and infrastigmatal series comparatively few, comparatively distant from the spiracles, and rather closely clustered.
 Bristles of subdorsal series much shorter than the others; most of the bristles of the upper half of the body distinctly clubbed; second series from the mediodorsal line distinctly lateral.....**Jasoniades.**
 Bristles of subdorsal series as long as the others; the bristles of upper half of body very faintly enlarged at tip; second series from the mediodorsal line supralateral.....**Euphoeades.**
 Bristles of the supralateral series six to eight in number and hardly diminishing in importance in the middle of the body, as do the tubercles they rest upon; bristles of the supra- and infrastigmatal series numerous, loosely clustered, approximating the spiracles so as almost to surround them.
 Suprastigmatal tubercles of first thoracic segment conspicuously larger than the rest, nearly doubling the width of the segment, their base half as thick as the segment....**Heracilides.**
 Suprastigmatal tubercles of first thoracic segment not conspicuously larger than the others, their base not one-fourth as thick as the segment.....**Papilio.**

Table of genera, based on the mature caterpillar.

- Body furnished with a series of large fleshy filaments on the sides.....**Laertias.**
 Body without lateral filaments.
 Third thoracic segments distinctly larger than the anterior abdominal segments.
 Third thoracic segment with no transverse dorsal ridge.
 Third thoracic segment with no central markings; first abdominal segment marked in front with a transverse, dorsal stripe; other abdominal segments with transverse linear markings.....**Iphicilides.**
 Third thoracic segment with a pair of conspicuous compound ocelli in the middle; first abdominal segment marked behind with a transverse dorsal stripe; no transverse markings on the remaining abdominal segments.
 First abdominal segment with no large, bright patches.....**Jasoniades.**
 First abdominal segment with a pair of laterodorsal, black-edged, bright patches, nearly as large as the ocelli in front of them.....**Euphoeades.**
 Third thoracic segment with a transverse, arcuate, dorsal ridge.....**Heracilides.**
 Hinder thoracic segments scarcely larger than the succeeding segments. Body conspicuously and transversely banded throughout with black.....**Papilio.**

Table of genera, based on the chrysalis.

- Surface of body, apart from the large projections, tolerably smooth; curve uniting the ocellar prominences in front uniform.
- Supralateral ridges on abdomen; infrastigmatal abdominal ridges not extending along whole side of body.
- Ventral surface swollen and bent in the middle; abdomen much expanded laterally next the base.....**Laertiias.**
- Ventral surface nearly straight; abdomen not expanded laterally next the base.....**Iphicliides.**
- No supralateral ridge on abdomen; an unbroken infrastigmatal abdominal ridge, extending without break to ocellar prominences.....**Euphœades.**
- Surface of body apart from the large projections markedly rugose; curve uniting ocellar prominences in front irregularly stepped.
- Anterior half of body in same line with posterior half.....**Jasoniades.**
- Entire anterior half of body bent upwards at a considerable angle, the ventral surface especially being strongly angulated.
- A prominent compressed tubercle at base of antennae, nearly in continuation of superior ridge of ocellar prominences.....**Heraclides.**
- No basal ocellar tubercle as above.....**Papilio.**

Table of genera, based on the imago.

- Club of antennae nearly straight, curved upward almost imperceptibly; tip of abdomen almost reaching the apical excision of the inner margin of the hind wings; the same margin reflexed in the male, concealing androconia; no ocellus at anal angle of same wings.....**Laertiias.**
- Club of antennae arcuate, being strongly curved upward throughout its length; tip of abdomen not nearly reaching apical excision of inner margin of hind wings; same margin without fold or androconia; a more or less perfect bright ocellus at anal angle of same wings.
- Club of antennae ovate, thick, comparatively short; hind wings, exclusive of tails, nearly twice as long as broad.....**Iphicliides.**
- Club of antennae elongated, not very thick; hind wings, exclusive of tails, hardly more than half as long again as broad.
- Fore tibiae decidedly shorter than the tarsi; tails of hind wings more or less spatulate; interior armature of male abdominal clasp a strongly arcuate ribbon or rod.
- Submedian nervure of hind wings nearly straight; fourth superior subcostal nervure of fore wings arising at about one-third the distance from the tip of the cell to the tip of the wing; club of antennae shorter and relatively thicker than in *Heraclides*; principal markings of fore wings transverse; interior armature of male abdominal clasp with few, distant and prominent hooks.
- Discoidal cell of fore wings not more than three times longer than broad; vein connecting subcostal and median nervures, and closing the cell of hind wings, not much shorter than the short vein above it, and bent at an exceedingly broad angle with that below it; fore wings above with no transverse stripes.....**Jasoniades.**
- Discoidal cell of fore wings considerably more than three times longer than broad; vein connecting subcostal and median nervures, and closing the cell of hind wings, less than half as long as the short vein above it, and bent at little more than a right angle with that below it; fore wings above with transverse stripes.....**Euphœades.**
- Submedian nervure of hind wings strongly sinuate; fourth superior subcostal nervure of fore wings arising at much less than one-third the distance from the tip of the cell to the tip of the wing; club of antennae very long, slender and gradually incrassated; interior armature of male abdominal clasp continuously and minutely denticulate; principal markings of fore wings subparallel to the costal margin.....**Heraclides.**
- Fore tibiae decidedly longer than the tarsi; tails of hind wings not at all spatulate; interior armature of male abdominal clasp a straight serrated rod.....**Papilio.**

LAERTIAS HÜBNER.

Laertias Hübn.. Verz. bek. schmett., 84 (1816). Papilio (pars) Auctorum.

Type.—*Papilio philenor* Linn.

Stay near me—do not take thy flight!
 A little longer stay in sight!
 Much converse do I find in thee,
 Historian of my infancy!
 Float near me; do not yet depart!
 Dead times revive in thee;
 Thou bring'st, gay creature as thou art!
 A solemn image to my heart,
 My father's family!
 Oh! pleasant, pleasant were the days,
 The time, when in our childish plays,
 My sister Emmeline and I
 Together chased the butterfly!
 A very hunter did I rush
 Upon the prey:—with leaps and springs
 I followed on from brake to bush;
 But she, God love her! feared to brush
 The dust from off its wings.

WORDSWORTH.—*To a Butterfly.*

Imago (56: 8). Head large, covered with not very long, erect hairs, behind the antennae very short. Front very little tumid, a little protuberant in the middle of the lower border, on the lower half projecting somewhat beyond the front of the eyes; at the sides, especially above, the front is considerably depressed below the eyes, and next the border there is a slight sulcation directed toward the outer edge of the antennae. Deeper than in the other genera; below the antennae the front is scarcely higher than broad and a little more than three-quarters as broad as the eyes on a front view; upper border projecting rather broadly to meet the vertex and in front of the antennae it is sloped, scarcely rounded, not curving back again on their outer side; middle of lower border rather strongly rounded. Vertex considerably tumid, especially in the middle, protuberant at the outer anterior angles, slightly hollowed in the middle in front, with a short sulcation behind the middle of each antenna. Eyes very large, very full, naked. Antennae inserted in the middle of the summit, separated by more than half the diameter of the second antennal joint; a little longer than the abdomen, composed of thirty-eight joints, each expanding at its apical extremity just enough to enclose the base of the succeeding joint, the terminal ten or eleven forming a cylindrical club, flattened on the under surface, about three times as broad as the stalk and four times as long as broad, the basal joints increasing so gradually that the limits of the club are difficult to define; afterwards more rapidly, largest on the third to the sixth joints from the tip; the apical two joints face a little outward and form a well rounded tip, which is interrupted, especially in the female, by the minute conical extremity of the apical joint; edges of the joints continuous. Palpi very minute and slender, fringed with long hairs and reaching the middle of the front of the eyes.

Prothoracic lobes obsolete. Patagia small, twice as long as broad, flat, not arched, slightly falciform, the posterior lobe tapering rapidly to a blunt point, the inner edge well rounded, the outer rather regularly concave, diminishing in size from the very base.

Fore wings (40: 8) twice as long as broad, the basal half of the costal margin very slightly convex, in the middle of the apical two-thirds scarcely inflected, next the tip curving backward more strongly, the apical angle rounded off to a great degree; outer border nearly straight, very little crenulate on the lower half, the subcostal region a very little full, the direction of the border scarcely at an angle of 40° with the middle of the costal border; inner border slightly and broadly sinuous, the outer angle well rounded. First superior subcostal branch arising in the middle of the outer four-fifths

of the upper margin of the cell, second at less than one-third the distance from that to the apex of the cell, the third at the apex and the fourth at one-third the distance from that to the outer margin; cell somewhat more than half as long as the wing, three and a half times longer than broad; at the origin of the fourth median branch the main vein is raised above the continuation of its basal half by two-thirds the width of the last median interspace at its base; cross vein connecting median with submedian near the base directed straight downward.

Hind wings with the costal border considerably and roundly expanded next the base, beyond either slightly convex (δ) or nearly straight (φ), well rounded off in both sexes to the strongly crenulate hind border which is well rounded, but much more produced in the lower half in the φ , and proportionally fuller in the subcostal region in the δ , the median portion of the border being, in both sexes, at an angle of about 110° with the subcostal; the upper median nervule is produced into a long equal tail five or six times as long as broad, its tip tapering to a rounded point; just beyond the tip of the lowest median nervule the border rounds off and recedes abruptly to more than the width of an interspace, at the same time approaching somewhat the nervule and then continues on a course at a slight angle with that of the lower half of the wing, the angle well rounded; inner border a little folded, slightly concave. Subcostal nervule nearly straight between the bases of the first and second nervules; vein closing the cell slightly longer than the space between the bases of the second and third median nervules.

Fore femora and tarsi of equal length and nearly half as long again as the fore tibiae; middle tibiae as long (δ) or five-sixths as long (φ) as the femora, the tarsi somewhat longer; hind femora shorter than the tibiae and these than the tarsi, which are a third longer than the femora; femora of nearly equal length, the middle pair longest, the hinder shortest; middle and hind tibiae of equal length and about half as long again as the fore tibiae; hind pair of tarsi somewhat longer than the middle pair and more than a third longer than the fore tarsi. Tibiae furnished with four rows of rather long and very slender spines, one on either side below and one on either side above, all directed forward, but those in the upper rows horizontally, the others spread at an angle outward; besides these, there are, especially near the tip, a few other smaller spines, irregularly disposed, and on the inner side of the tip beneath a single long and very slender spur, surrounded by a few stoutish spines. First joint of tarsi equal to the three succeeding taken together, these scarcely diminishing in size in regular sequence, the fifth equal to the second, all furnished beneath on either side with a row of frequent, very small and slender spines, those of the inner side not spreading laterally; and at the tip of each joint a much longer and very slender spur, and three or four supplementary ones at nearly equal distances on the basal joint; on either side above, two rows of frequent, minute, nearly recumbent spines; claws long and very slender, a little compressed, the under edge straight, the upper very slightly curved, the tip finely pointed and scarcely curved; paronychial and puvilli wanting. Hook of eighth abdominal segment of male rather slender at the base, the tip bluntly pointed; valves very short, tumid at base, right angled at tip, of about equal length and breadth, slightly armed within at the extreme base.

Egg. Nearly globular, with base slightly flattened, leaving the height and width equal; surface granulated, covered with minute, irregular globules of oily looking matter.

Caterpillar at birth. Head smooth, well rounded, theiform, twice as broad as long or deep. Body nearly cylindrical, a little angulated along the line of the upper row of tubercles, perhaps largest on the first thoracic segment, which bears a superior shield, the posterior half of the body smaller than the anterior half. There are laterodorsal, infralateral, suprastigmatal, infrastigmatal and ventrostigmatal rows of large, subconical tubercles, one to a segment in each row, each of those above the spiracles bearing, at least on the abdominal segments, a single long, straight, non-tapering bristle, those below and some thoracic ones above bearing a slight whorl of shorter but similar bristles; the infralateral tubercles are situated mesially on each

segment, the others slightly in advance of the middle. The tubercles are perhaps slightly larger on the thoracic segments, and especially the infrastigmatal tubercle of the first segment (here become stigmatal) which is very prominent, mammiform. There are no surface hairs.

The two upper series of tubercles in the figure (72: 7) should be of a more nearly equal size, farther apart and both at a lower situation.

Mature caterpillar. Head small, rounded, subquadrate, of about equal height and breadth. Body nearly cylindrical, with a little tendency to a laterodorsal angle, tapering considerably forwards on the thoracic segments, and a little larger on the anterior abdominal segments than behind. From the second thoracic to the ninth abdominal segments a pair of supralateral, fleshy tubercles, of uniform and not great elevation from the sixth abdominal segment forward, behind this long and conspicuous, particularly on the ninth abdominal segment; the shorter ones are but little if any longer than broad and very slightly appressed, the longer ones are distinctly appressed and are straight or slightly curved, directed upward, backward and slightly outward; another and suprastigmatal row of fleshy filaments, extending over the thoracic and first abdominal segments in a slightly oblique course is more conspicuous, the filaments, with the exception of that on the first abdominal segment, which resembles those of the row above, being very long and slender, and on the first thoracic segment exceedingly long and flexible; the others are directed outward and curved forward, and are a little longer than the segment bearing them; there is a single infrastigmatal filament on the second abdominal segment, similar to those of the next row above, on the second and third thoracic segments; the third to the sixth abdominal segments have also a long, outward directed tubercle at the base of the prolegs, curved a little downward, and the seventh and eighth a similar one a little higher on the side of the body.

Chrysalis. Body very irregular in shape, smooth, the abdomen occupying three-fifths of the whole body. Viewed laterally, the anterior two-fifths of the body is bent upward at an angle of about 55° with the posterior portion, as indicated by the rounded bend of the lower surface just beyond the middle of the wings; the anterior part of the lower surface is straight, the posterior very slightly concave. The upper surface of the head is flattened, bounded by slight ridges, that in front depressed, and separating it from the lower surface at an angle of about 70° ; this same ridge is transversely a little concave or scarcely angular, connecting the apices of the ocellar prominences, which are pyramidal, trigonal, large, divergent at nearly a right angle, all the angles ridged, compressed and rugulose, the anterior carina extending in a double curve, notched in the middle to the most posterior portion of the head; the posterior carina directed toward the middle of the mesonotum, at first not descending, making the ocellar prominence appear docked on a side view, then bent at a right angle and afterwards resuming the slope as if it had started from the apex; prothorax considerably hollowed, especially in front, separated by a carinate ridge along its whole anterior border from the parts in front. Mesothorax tumid, bearing in its centre a very high, abrupt, pyramidal, trigonal, upward directed tubercle, bluntly rounded at tip, its angles heavily carinated and rugulose and rounded, the posterior ones strongly arched and furnished at their base with a minute wart, the sides, especially the posterior face, hollowed, the summit rounded; the anterior slope of the mesothorax continuous with that of the prothorax, and not so greatly angulated with that of the tubercle as the posterior slope, which is continuous with the anterior half of the metathorax, where the body is considerably angulated. Viewed from above, the sides of the mesothorax are straight and parallel, or diverge slightly in front, as far as the basal wing tubercle; in front of that, to the base of the ocellar prominences, the sides of the body taper slightly; the basal wing tubercle is large, prominent, somewhat transverse but slightly pyramidal, trigonal, the posterior face broadest, appressed and nearly transverse, the anterior rounded, its carina obscure. Viewed laterally the abdomen is nearly equal on its basal two-thirds, and beyond that tapers regularly; its superior curve is regular from the fourth segment backward, and in advance of that the dorsal surface is straight; the first four segments are greatly ex-

panded, to nearly double the width of the metathorax, the superior edges of the wings partaking of the dilatation, the outline of the whole being strongly and regularly curved, and the lateral ridge thus formed very sharp and greatly depressed; transversely these segments are broadly rounded. On either side of the fourth to seventh abdominal segments is a laterodorsal series of greatly compressed, elevated, laminate ridges, the edges of which are regularly rounded longitudinally and rugulose; in continuation of these are slight carinae, converging to the superior sides of the cremaster; between them the surface is nearly flat, and below them the sides of the abdomen are scarcely rounded, steeply sloped; in posterior continuation of the lateral expansion of the anterior part of the abdomen is a substigmatal carina, indistinct and rounded on the fifth and sixth segments, extending to the inferior sides of the cremaster; beneath, the abdomen is broadly rounded transversely. Preanal button bounded by very broad, low walls, increasing in breadth and diverging anteriorly, then suddenly bending at right angles toward each other, meeting and emitting from the posterior border, at equal distances from the sides, a pair of small, depressed, recumbent, rounded, lobe-like tubercles, directed backward. Cremaster short and broad, tapering strongly, much broader below than above, the sides strongly hollowed, the upper portion equal until near the tip, carinate at the sides, broadly docked at tip, the apical field of anal hooklets nearly circular, but docked a little beneath. Hooklets short, the stem a little curved, quite stout, increasing in size a little toward the apical expanded portion, which is suddenly enlarged to fully twice its breadth, curved strongly over and downwards, the sides produced in front and bluntly pointed, leaving the apical border emarginate.

This group of swallow-tails is peculiar to the southern portion of North America and is apparently composed of only two or three species, some belonging to the south and almost confined to the Antilles; the last (here described) belonging to the north and far more widely spread.

This group stands apart from the other New England genera of Papilioninae and approaches more nearly in structure the gigantic Ornithopterae of the East Indies; but it is still more closely allied to the tailless genus *Ithobalus*, belonging to tropical America, the transformations of two or three of whose species are known through Burmeister.

The butterflies are among the smaller of the swallow-tails, but still large and magnificent, of an intense black, shading off into brilliant metallic tints of green and steel as the light strikes across the wings; the outer border has a submarginal series of large, pale greenish spots and the upper median nervule bears a subspatulate tail; beneath, the fore wings are duller, the pale spots repeated, but the outer half of the hind wings is even more brilliant and variegated than above, the spots being much larger and changing to deep orange, and the wings more or less spotted with white. "These gorgeous swallow-tails," says Gosse, "seem to be of royal blood, to have a presence that distinguishes them from the meaner herd" (Lett. Alab., 78).

The genus is peculiar among our swallow-tails for the length of the middle tarsi and the slight inequality in the length of the antennae in the two sexes, those of the male being relatively the longer. The males have a reflected inner margin to their hind wings as far as the internal nervure, which is enveloped in the fold which conceals androconia. One spe-

cies, our own, is said to exhale a disagreeable odor (though I could perceive none in a fresh male), another a strong musky odor, and in the neighboring genus *Ithobalus*, where the fold is wanting, the males have sometimes two classes of odors, according to Fritz Müller.

The more or less complete history of all the species is known. They are digoneutic or polygoneutic and supposed to winter as butterflies. The eggs hatch in a week or more, the caterpillars mature in two or three weeks, and the chrysalids hang from two to four weeks; the ratio of pupal to larval life being exceptionally large and the more remarkable in an insect which does not appear to hibernate in the chrysalis stage. The eggs are laid in small and rather open clusters, and the caterpillars feed openly but on the underside of leaves, sometimes alone, sometimes in small companies on *Aristolochia* and occasionally on allied plants.

The eggs are nearly globular and covered with a waxy secretion in vertical ridges which give it somewhat the appearance of a melon.

The juvenile caterpillars are cylindrical, covered with series of conical tubercles, highest in front and behind, most of them bearing only a single tapering bristle a little longer than the segments. After the first moult, these are exchanged for short fleshy tubercles of subequal length, a condition which is perpetuated in the neighboring genus *Ithobalus*. In the mature caterpillars, however, these are unequal and the first pair extremely long; the body, which "becomes more elongated" (Harris) is of a rich dark brown, the longer tubercles red on the basal half, the shorter ones wholly pale yellow.

The chrysalids are green or red and very oddly formed; the inferior curve of the body is strongly sinuate, the back of the thorax furnished with a very prominent pyramidal ridge, the base of the abdomen strongly and roundly expanded on the sides, while the segments behind are conspicuously ridged on either side of the back.

EXCURSUS XLVII.—A STUDY OF CERTAIN CATERPILLARS.

All men are worms: but this no man. In silk
 'Twas brought to court first wrapt, and white as milk;
 Where afterwards it grew a butterfly,
 Whence was a caterpillar: so 'twill die.

BEN JONSON.—*On Court-Worm*.

The bug, which you would fright me with, I seek.
 SHAKESPEARE.—*Winter's Tale*.

INTERESTING as are the transformations of a butterfly in the three earlier periods of its life, marked off by such strict lines from one another, the changes which the same insect undergoes in shape, in color and in clothing in the different stages of caterpillar life alone, are scarcely less

surprising. Attention has already been drawn to this point in a general way (pp. 804-808), but it is true to so marked an extent in the caterpillars of our swallow-tails that it seems well to recur to it in a more precise manner; for if in their earliest stages these caterpillars were only large enough to have all their peculiarities readily seen by the naked eye, more attention would long ago have been given them. It is also important on other grounds. Weismann has mentioned the desirability of studying the early stages of these caterpillars in particular, to acquire a knowledge of their phylogeny, and they have formed the subject of an extended but still incomplete paper by Gruber,* somewhat barren in results from its incompleteness, and in some particulars from its inaccuracy. The more complete material now at hand, studied almost entirely from fresh objects, the extraordinary variety among our New England forms, and the curious fact that these cover almost the entire range of variation known among the caterpillars of Papilionidi the world over, lend special interest to such an enquiry.

I propose in the first place to give for each of the six species of our fauna, each representing a distinct genus, as succinct an account as possible of the several important changes; next to summarize from this the leading lines along which the changes have occurred; and finally to draw from the facts such conclusions as seem admissible. I follow the order of the text of the present work.

The caterpillar of *Laertias* at birth is uniformly cylindrical, of a uniform dark brown, covered with several rows of conical warts of nearly uniform size, most of them bearing a single bristle, a few, on the thoracic segments and just above the abdominal legs, more than one. In its second stage the shape and coloring are the same as before, but the clothing of the body is greatly changed, for all the warts bearing single bristles have disappeared, together with their bristles, and so have the bristles of the other warts, but in these latter instances the warts remain, and have become short, fleshy, often brightly colored filaments; while to take the place of the simpler warts a new and independent series of fleshy filaments has arisen between the two series which disappeared. The remaining stages are much the same as this, only the filaments at the extremities of the body grow longer and longer with each stage, more and more highly colored; a suprastigmatal series of coral red spots is introduced in the fourth stage on some of the abdominal segments; and finally, in the last two stages, the thoracic segments taper forwards markedly.

The new-born *Iphiclides* is cylindrical, but a little larger in front than behind, of a nearly uniform dark leaden color, darker, however, on the front half than behind, covered with rounded warts arranged in several rows, a few at the extremities slightly larger than the others, most of them support-

*Jen. zeitschr. naturw., xvii; Papilio, iv.

ing a number of bristles, generally widely forked at the tip. In the second stage every trace of tubercles and bristles, forked or simple, has gone, excepting a few slight, spineless warts at the extremities, and in their place fine, excessively short hairs are scattered over the body; this has become tumid on the thoracic segments, and is transversely striped with uniform black and white or yellowish bands, of which there are many to a segment. In the third stage the hairs are even less observable, and the stripes have become finer and tremulous, while the incisure between the last thoracic and first abdominal segment is marked by a broad, black, velvety stripe, edged in front with white and behind with yellow. The fourth stage shows no special change. In the fifth the broad, velvety stripe becomes more conspicuous, because the ordinary stripes become more or less obsolete; and when full grown the latter often or generally persist only as transverse series of black dots on a nearly uniform green body, though the yellow stripes remain, at least on the sides.

In *Jasoniades* the infant caterpillar is cylindrical, slightly tumid anteriorly, of a dark brown or sometimes even velvety black color, a little paler beneath, the extremities lighter, and an oblique stripe in the middle above on each side, forming a sort of saddle-shaped, whitish mark; the body is covered with several series of wart-like tubercles, larger at the extremities than in the middle of the body, beset with bristles. In the second stage tubercles and bristles are gone, excepting at the extremities of the body, where they are relatively much reduced; the color and markings remain much as before, but are perhaps more diversified, and have added to them on the sides of many of the segments next the tubercles a minute bluish spot, that of the third thoracic segment (now more distinctly tumid) with a velvety black streak below it. In the third stage all the markings are still more distinct and diversified, and the tubercles have almost entirely disappeared and been replaced by smooth, shining lenticles, while on the sides of the third thoracic segment the blue spot and black streak have developed to a black annulus with a blue centre. In the fourth stage the general color becomes at first a dark brownish olivaceous, with the same striking contrasts as before, but during the course of this stage this is replaced by a grayish green, and the saddle, which has been becoming yellow, fades and diminishes until a mere ghost remains; the first abdominal segment is edged behind with yellow, the lenticles have turned to colored spots, and on the third thoracic segment is seen at first a pair of roseate spots faintly edged with black, and a black line between them, afterwards becoming a single yellow spot, including below a luteous lenticle, above a velvety black streak, and in the middle a black-rimmed, turquoise spot. In the final stage the caterpillar becomes pure green above, pale bluish green below, and the only markings are a bright, transverse stripe of black and yellow at the hind edge of the first abdominal segment, a few

rows of minute dark turquoise spots, and on the sides of the third thoracic segment a still further development of the markings, the whole now forming a rounded, quadrangular, greenish yellow spot, rimmed delicately with black, crossed above by a black bar, and enclosing below a black annulus with a turquoise centre.

In *Euphocades* we start in practically the same way as in *Jasoniades*, only the saddle is less oblique. In the second stage the caterpillar is plumbeous, with the lateral flaps of the pale saddle more distinct than the seat, the body paler below than above, and there is added a curving white streak below the middle of the sides of the thoracic segments, seeming to define better the tumid front portion of the body; bluish dots appear along the dorsal part of the segments, and on the third thoracic segment one at the side is velvety black, edged above and below with yellow; the tubercles are only distinct at the extremities of the body. The third stage hardly differs from the second, but the spot on the third thoracic segment is now larger and wholly rimmed with yellow. The fourth stage also closely resembles the preceding, but the tubercles are replaced by lenticles, one on the third thoracic segment black and glistening, and included in the black spot. The last stage is wholly different, the general color being a pure green, on which only the minor spots remain as links to the past, and reinforced by others which replace the lenticles; the spot of the third thoracic segment has altered; it is now a finely black-rimmed, large, orange and yellow spot, including a quadrate black nucleus below the middle, nearly half as large as the whole spot, and including within it posteriorly a shining black, blue-edged lenticle; a thin black line runs between this nucleus and the outer black rim in front; but an additional spot appears on each side above on the first abdominal segment, a large, finely black-rimmed, rounded orange spot seated at the posterior incisure on a fine black line which enlarges where the spot touches it; the two series of small abdominal spots have become distinctly turquoise.

In *Heraclides* the young larva is provided with exceptionally large tubercles, which are largest at the two extremities, and especially on the first thoracic segment, and these are all thickly beset with bristles; the body is largest in front but scarcely tumid; the colors are very dark brown, more or less mottled, with a distinct white saddle and lighter extremities. Excepting that the front portion of the body is a little tumid, and that the tubercles become relatively less important, there is no change in the next two stages. In the fourth stage the front part of the body becomes distinctly tumid and at the same time develops an irregular, white, curving lateral band, setting off the tumidity to better advantage; the colors and patterns are otherwise the same as before, but the tubercles have become lenticles, and around them have clustered rings of brighter color, by which the body is much mottled. No further change is made in the final stage

excepting that the colors are more varied, the whites have become more of a cream color, and the mottling is more noticeable, partly from the larger size; in general the disposition of the markings is much as in the newly born caterpillar.

In *Papilio*, finally, we have at birth a jet black caterpillar with a white saddle across the middle, and occasionally a white fleck or two in front of it; the body is cylindrical or nearly so, but the thorax shows a slight tumidity; it is tuberculate, with conical tubercles, beset with bristles; there is little inequality in the length of the tubercles, but those on the side of the body are dull orange. In the second and third stages we have a repetition of the same features in color, form and tubercles; the orange, however, becomes a little more vivid. In the fourth stage, too, the dark tubercles still remain but are relatively less important, and have at their anterior base a yellow or orange spot; while in the place of the orange tubercles are orange lenticles, and these and the other orange spots break what would otherwise be a broad, black, transverse band in the middle of each segment; for now the body has become green and is transversely striped with black in the middle and (more narrowly) at the front edge of each segment, and no sign whatever of the saddle remains; the form at the same time becomes more completely cylindrical, but the body tapers in front. In the last stage this general style of ornamentation and of form is kept, but the tubercles and lenticles altogether disappear.

From these statements we see that there is a somewhat general uniformity of type in the earliest stage of larval life among the *Papilioninae*, while there is an extraordinary diversity in the same caterpillars when full grown. Some of them alter very much less than others, some assume the mature aspect by slow degrees, and others at a start and at very different periods of life. Thus maturity may be said to be assumed at the second stage by *Laertias* and *Iphiclides*, at the fourth by *Heraclides* and *Papilio*, in the course of the fourth stage by *Jasoniades*, and not until the final stage by *Euphocades*. This assumption of maturity consists in several distinct features which *in general* are correlated: the form of the body, the broad features of the coloring of the body and the loss of the juvenile armature. In only one instance, *Papilio*, are the tubercles of the larva retained (and here only for a single stage) after the adult form and markings have appeared; and, excepting *Laertias* where the markings are almost null through life, *Heraclides* is the only example where the ornamentation of the body of the adult in any way resembles that of the newly born caterpillar.

There are several distinct lines along which changes have occurred, permitting readier comparison between allied types, and to set this forth more clearly the facts are tabulated on the next page, the numerals representing the stages.

Characteristics.	Lac- taria.	Iphi- clides.	Jason- lades.	Euphoe- rides.	Hera- clides.	Papilio.
Tubercles large and bristly	1	1	1	1	1	1-3
" diminished, often without bristles			2	2-3	2-3	4
" changed to lenticles			3	1	4-5	4
Lenticles changed to spots	2-5		4	5		5
No conspicuous tubercles	2-5	2-5	3-5	4-5	4-5	5
Filaments	2-5	0	0	0	0	0
Body pretty uniformly cylindrical	1-3	1	1	1	1	
" slightly tumid in front			2		2-3	1-3
" distinctly " " " " " " " " " " " " " "			3-5	2-5	4-5	
" tapering in front						4-5
Color almost entirely brown	4-5					
" dark, saddled with light	1-5	1				
" transversely striped with black and bright green			1-4½	1-4	1-5	1-6
" almost entirely green			2-5			4-5
Curving lateral stripe in front	0	0	0	2-4	4-5	0
Bright spots in rows on abdominal segments	2-5	0	2-5	2-5	0	2-5
A thoracic ocellus	0	0	<2-5	<2-5	0	0
Special markings on first abdominal segment	0	0	4½-5	5	0	0

From this it would appear to be tolerably clear that the primaevæ caterpillar of the Papilioninæ was covered with rows of fleshy, mammiform tubercles beset with bristles, and that these were retained through life; but that in the gradual development of the group these were lost, first at the final stage as we now find it in Papilio, afterwards at successively earlier and earlier stages; the loss consisting, first, in the removal of the bristles, afterwards in the lowering of the tubercles until only smooth and shining lenticles remained, as now in the full grown caterpillar of *Heracles*; these again, as in several genera, were replaced by colored spots, some of which, in caterpillars so far developed as *Euphocædes* and *Jasoniades*, assumed special forms.

So when we come to the general color, it may be fairly presumed that the early caterpillar was of a dark color—in no way green as Weismann, from his study of the Sphingidae, seems to think all young caterpillars were; probably of a uniform dark color with a tendency toward a deepening of the tint of the region about the third thoracic segment (which early assumes a special importance in these caterpillars), and also about the seventh abdominal segment, by the tendency of both markings and dermal appendages to assume a polar arrangement in elongated forms. By this means and through the intensification of these contrasts arose the lightening of the middle parts of the body to form a saddle-shaped, whitish patch—a marking surely of great antiquity in swallow-tail caterpillars, since it is now found at birth in four of our six genera, and a fifth shows a tendency toward it. This style of marking has been retained throughout life in *Heracleides* only of all the members of our fauna; and as it is in just this genus alone that the lenticle-traces of the tubercles persist to maturity, we have certainly in *Heracleides* the perpetuation of a very antiquated type.

That in *Papilio* we have also a very persistent type may be judged from the great stability of the upper tubercles, which are even not lost until after the assumption of the changed livery of maturity,—a livery which

owes a part of its variety and enlivenment to exchange of some of these tubercles for bright colored spots; these break up the transverse black stripes in a variable degree, and the stripes themselves appear to be but little more than retention of parts of the original color (fixed at the particular spot they occupy by the central position of the black tubercles) when the green livery of adult life is assumed. For it seems to be a green resembling the green of the leaves upon which the caterpillar lives, that is the ultimate aim of most Papilionid coloration. In caterpillars of their size other colors would be too conspicuous for their advantage and variation in this direction would be natural. Moreover, it is the color reached or partly reached, in several different ways, as the development of the other types show; thus in the other striped caterpillar, *Iphiclides*, the stripes grow obsolescent toward maturity and leave the caterpillar more completely green.

We may then trace several lines, to a certain extent parallel, along which the modification of the caterpillars of Papilioninae has developed, parallel at least in that the loss of the juvenile bristles has been universal but at different stages; also that the loss of the juvenile tubercles has been universal though not always complete, their loss being generally made good by lenticles and these by spots; and sometimes, by acceleration, a phyletic stage is set further and further back and finally, perhaps, crowded out.

One of these lines, very distinct from the others, is found in *Laertias*, which has developed to so high a degree that its juvenile bristles, themselves exceptionally simple, are completely lost with the earliest stage; so, too, most of the tubercles; but here a very curious change occurs: those which are lost are replaced in new positions by others entirely different, which take on a more elongated form and become more properly fleshy filaments; while those which remain assume also the new development. The dark and almost uniform color of the larva throughout life is to be explained probably by acceleration; it is the mature color thrust back into the juvenile stage, to the obliteration of any trace of the saddle which once may have prevailed there; and is in keeping with the present almost complete assumption of the mature characters at the second larval stage. In support of this position I would point out that traces of the saddle still exist in the mature forms of other filamentous caterpillars of Papilioninae allied to *Laertias*,—*Ornithoptera*, *Menelaides*, etc., indicating a still larger development of the same in the earlier stages of the types with which, unfortunately, we are not yet acquainted. In *Laertias*, then, the saddle has been crowded back out of existence.

Another line of nearly as high development we find in *Iphiclides*, where the extraordinary bristles and tubercles are lost with the very first stage and maturity marks the second. Here again no saddle appears, the only trace of it left being in the slight deepening of the color in the new-born caterpillar near the extremities of the body; here I conceive that the phy-

letic stage marked by the saddle and formerly developed in later stages from the incipient contrasts of the first, has been pushed back without invading the first until it is entirely skipped.

A third line is represented by the remaining genera in which the saddle is definitely formed and becomes a marked feature of the earliest stages, to be lost only at a comparatively late period of life,—in one instance, *Heraclides*, not at all. Its loss, however, is effected in two very different methods, as already pointed out, in *Papilio* and in the other genera, indicating lines along which future strikingly different processes may go on with widely different results;—in curious contrast to the somewhat similar results following quite different lines which we see in *Iphiclides* and *Papilio*. In *Euphacides* and *Jasonides* we see also the development of special and complicated markings from the simple spots which have replaced the tubercles: traces of the same may be seen in *Heraclides*.

This review has but imperfectly shown what curious and striking distinctions in form and coloring are possible, distinctions which indicate within the history of single lives the immense phyletic changes that have occurred within the group. These changes are far greater both in structure and in design than can be proved to have occurred in other phyletic types among butterflies, to which have been universally accorded by the most conservative of systematists the rank of genera. Shall we refuse to recognize and so consign to oblivion the more interesting, more important and more obvious differences which here obtain, by classing all these forms under one, wide-reaching generic name? It were a veritable travesty of Nature.

LAERTIAS PHILENOR.—The blue swallow-tail.

[The blue swallow-tail (Gosse); conjugal Papilion (Emmons); Philenor swallow-tail (Riley); orange-banded butterfly (Maynard).]

Papilio philenor Linn., Mant. plant., 535 (1771);—Jabl., Natursyst. ins. schmett., ii: 271-273, pl. 19, figs. 2, 3 (1784);—Panz., Drur. abhild., 54-55, pl. 11, figs. 1, 4 (1785);—Abb.-Smith, Lep. ins. Ga., i: 5-6, pl. 3 (1797);—Esp., Ausl. schmett., i: 40-50, pl. 11, fig. 3 (1801);—Say, Amer. entom., i, pl. 1, (1817, 1824); Entom. N. Amer., ed. LeConte, i: 1-2, pl. 1 (1859);—Boisd.-Lee, Léop. Amér. sept., 29-31, pl. 11, figs. 1-4 (1833);—Boisd., Spec. gén. Léop., i: 324-325 (1836);—Lucas, Pap., 50-51 (1838);—Westw., Drury, Exot. entom., i: 20-21, pl. 11, figs. 1, 4 (1837);—Harr., Entom., 60-61 (1841); Entom. corresp., 147-148, 273-274, figs. 37, 38 (1869);—Lucas, Léop. exot., 15, pl. 8, fig. inf. (1845);—Doubl., Arc. ent., i: 68 (1845);—Gray, List. Lep. Br. Mus., i, Pap., 75-76 (1856);—D'Urb., Can. nat. geol., iii: 400-402, figs. a, b (1858);—Morr., Syn. Lep. N. Amer., 6 (1862);—

Feld., Verh. zool.-bot. ver. Wien, xiv: 297 (1864);—Pack., Guide ins., 248, fig. 181 (1868);—Rhl., Rep. ins. Mo., ii: 116-118, figs. 84-86 (1870); Am. nat., 327-329, figs. 1-3 (1881);—H. Edw., Pac. coast Lep., 8-9 [ii: 2-3] (1873); 84 [xvi: 1] (1875);—French, Rep. ins. Ill., 7: 137-138 (1878); Butt. east. U. S., 80-89, figs. 11-13 (1886);—Saund., Rep. ent. soc. Ont., 1880, 39-40, figs. 10-18 (1881);—Edw., Can. ent., xiii: 9-14 (1880);—Middl., Rep. ins. Ill., x: 73-74, fig. 6 (1881);—Coq., ibid., 164, fig. 61 (1881);—Grub., Jen. zeitschr. naturw., xvii: 474-475, pl. 7, figs. 20-24 (1884);—Pap., iv: 88-89; pl. 2, figs. 20-24 (1884);—Mayn., Butt. N. E., 40, pl. 5, figs. 67, 67a (1886);—Abb., Draw. ins. Ga., Br. Mus., vi: 6, figs. 12, 13; xvi: 22, pl. 172.

Princeps dominans philenor Hüb., Samml. exot. schmett., i, Lep. i, Pap. ii,

Gent. II, Prince. B. Dom. c, figs. 1, 2 (1806).

Laertias phitenor Hübn., Verz. schmett., 84 (1815);—Scudd., Syst. rev. Amer. butt., 43 (1872); Geol. N. H., 1: 359, pl. A, fig. 15, 17 (1874).

Puchlopta phitenor Reak., Proc. entom. soc. Philad., III: 504 (1865).

Eg. Troj. astinuous Drury, Ill. nat. hist., 1:

21, pl. 11, figs. 1, 4 (1770).

Papilio astinuous Cram., Pap. exot., III: 26-27, pl. 208, figs. A, B (1782).

Figured also by Glover, Ill. N. A. Lep., pl. 9, fig. 18 (2 figs.); pl. 26, fig. 1; pl. 108, fig. 23; pl. 117, fig. 17 (2 figs.), ined.

Voyez ce papillon échappé du tombeau,
Sa mort fut un sommeil, et sa tombe un berceau;
Il brise le fourreau qui l'enchaînait dans l'ombre;
Deux yeux parlent son front, et ses yeux sont sans nombre;
Il se traînoit à peine, il part comme l'éclair;
Il rampe sur la terre, il voltige dans l'air.

DELLILE.—*Les Trois Regnes.*

With radiance caught for the occasion,—hues
Of blackest hell now, now such reds and blues
As only heaven could fitly interfuse.

BROWNING.—*Dramatis Personae.*

Imago (16:3). Head black; a minute pale yellow spot at the posterior base of each antenna; a narrow streak of the same, bordering the middle of the posterior edge of the eye and half its length; a few similar inconspicuous scales bordering the eye beneath; down the whole front, below each antenna, a row of pale yellow hairs intermingled with and so obscured by black hairs, either dividing the front in equal stripes of black and colored hairs (♀), or forming a slender line (♂). Antennae velvety blackish brown throughout. Palpi black, touched with a few pale yellow hairs in front. Tongue piceous, fusco-testaceous at tip.

Thorax covered above with blackish hairs, the patagia sometimes lined on either side with a few paler hairs; prothoracic lobes tipped each with a minute yellow spot, directly posterior to those on the head; behind these are two more, on the front of the mesothorax, and one at the base of the patagia placed in a transverse row with them, all at equal distances apart; beneath blackish with a small roundish yellow spot next the anterior base of each wing. Coxae covered with luteous black scales; anterior pair with a yellow streak occupying the posterior half of the basal half of the outer surface; a triangular spot of the same color occupies the middle of the basal half of the outer surface of the middle pair, and a large patch, becoming slenderer apically, the middle of the outer surface of the posterior pair; tibiae and tarsi blackish brown, the sides of the tips of the tarsal joints dark castaneous; spines black; spurs and claws mingled dark reddish and black.

Wings above. *Fore wings* lustrous blackish brown, the apex, beyond the cell, especially in the female, not quite so dark, the male sometimes with a faint violaceous or coppery green reflection; a submarginal series of small, pale yellow spots, distinct, faint or obsolete, distant from the outer border by the width of an interspace, situated one between each of the median interspaces, and two in the medio-submedian interspace; occasionally faint spots are also seen in the lower subcostal interspaces; fringe of the color of the wing, interrupted between most of the nervure tips with straw yellow, occupying, below the apex, about half of the space, and infringing very slightly upon the wing itself. *Hind wings* blackish with changeable reflections, either from very dark mulberry green to a bluish green (♀); or, from very brilliant metallic olive green to bright metallic blue (♂); a row of broad, large, pale pearl gray lunules, sometimes altered to transverse streaks or roundish spots, one at about the middle of the outer half of every subcostal and median interspace, subparallel to the outer border; fringe as on the fore wings and the tail fringed only with blackish.

Beneath: *Fore wings* blackish at base, gradually merging into the faded slate brown of the apical half, the veins darker; submarginal spots as on the upper surface, but much larger; a minute yellowish spot at the extreme base of the costal and median nervures; fringe as on the upper surface, but the yellow occasionally infringing to a greater extent upon the wing itself. *Hind wings* at base faded slate brown (with in-

frequent, scattered, delicate black hairs, the veins darker) reaching to just about the middle of the wing, its exterior limit parallel to the outer border and usually extending as far beyond the cell as the width of an interspace, but sometimes only as far as the cell itself; at the base a large roundish yellow spot, resting on and above the curve of the costal nervure; two small yellow spots at the extreme base, on either side of the principal insertion of the nervures; the apical half of the wing is very brilliant by reflected light, varying from bright olive green to dark metallic blue, scarcely tinged with green; next the upper border of this field, in the lower half of the wing, a few pearly white scales are collected in the middle of the interspaces; there is a submarginal row of seven very large, irregularly roundish, uniform orange spots, occupying the whole width of all the interspaces from the costal nervure to the inner border, broadly bordered above and below and partially at the sides with velvety black, partly obliterated by pearly white scales at the upper outer corner of the upper five spots and at the lower outer corner of the fifth and sixth; the upper spot is situated in the middle of the costo-subcostal interspace; the second a little beyond the middle of the upper subcostal interspace; the inner border of the third and fourth in the middle of the two succeeding; the fifth in the middle of the outer half of the upper median interspace; the inner border of the sixth in the middle of the lower median interspace; and the inner border of the seventh striking the middle of the upper half of the lower median nervule; fringe interrupted as on the upper surface, but the straw yellow infringes on the wing itself, forming lunate or irregular patches of considerable size, usually more or less faintly edged with blackish.

Abdomen above and on sides dark blue black, with blue reflections; at the lower border of the sides a series of rather small, triangular, yellowish spots at the tip of each segment; beneath the same and on each side a similar spot at the apex of each segment. Valves of male (35:24, 25) scarcely so long as broad, gibbous, subtriangular, roundly right-angled at tip, the upper border well-rounded, the lower nearly straight, armed within at the extreme base with a vertical, median, arcuate, rather slender, corneous ridge bearing a median and an inferior suppressed but rather stout denticle, scarcely curving downward.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 21; of talls, 6						
Length of fore wings.....	44.	47.5	49.	42.5	50.25	58.5
antennae.....	16.25	16.75	17.25	14.	16.25	20.
hind tibiae and tarsi..	14.5	15.5	16.5	14.5	16.	18.
fore tibiae and tarsi..	10.5	11.	11.	11.25	11.5	13.2

Malformations. Many years ago I saw in the collection of Mr. H. Strecker a specimen with the wings of the left side curiously affected, probably by some accident to the chrysalis. The fore wing had a rather deep rounded emargination in the middle of the outer border; the hind wing had on the inner margin just before the anal angle, a similar but much narrower, very deep and conspicuous rounded excision.

Mr. Strecker reports (Butt. rel. agric., 16) that he has two examples "in which parts of three wings are male and part female."

Secondary sexual distinctions. Besides the slight distinctions in the form of the hind wing mentioned in the generic description, the middle tibiae of the male are slightly longer than those of the female. The same is the case with the antennae, which are relatively longer in the male. But the most striking difference is in the close reflection of the inner margin of the hind wing (43:19) over the submedian nervure which is furnished on its exposed side with long bristles; this forms a slit-like semi-annular pocket (45:5) the opening of which is controlled by the free reflected margin, and whose walls upon both sides (45:4) are studded pretty uniformly but not serially nor very thickly with fan-shaped androconia (46:42) having a moderately short pedicel and an apically truncate, broad, ovate lamina with five or six prominent diverging ribs; the pedicel is set in an infundibuliform socket (not shown in the

figure), which is nearly as broad and as long as the globular basal attachment to the membrane; they are smaller than the ordinary scales, the lamina being only .742 mm. in length.

Egg (66: 4) Irregularly granulose, but almost completely hidden by the coating of salmon red oily material by which it is besmeared, concealing the natural dull watery olive color of the whole, as well as not permitting the micropyle to be distinctly seen. In one there seemed to be a close rosette of 6-8 kite-shaped cells forming a sunken depression about .05 mm. in diameter; and minute cells of a circular shape appeared to surround it. The egg is 1.05 mm. in diameter and in height.

Caterpillar. First stage (72: 7). Head (80: 1) shining olive black, the mouth parts the same but the base of the labium and antennae dull ochraceous. Body uniform brown ochraceous, dorsal shield of first and last segments and tubercles dark olive brown; bristles nearly as long as the diameter of the body, black, with extreme tip white. They have a scarcely perceptible taper and at tip bear an oval bulb of nearly the diameter of the base of the tubercle and colorless, giving it a whitish appearance against the black stem. Legs blackish; prolegs blackish brown. Length, 2.5 mm.; breadth, .4 mm.; length of bristles, .3 mm.

Second stage. Head (80: 2) shining black covered sparsely with black hairs. Body a little stouter on anterior than on posterior half, dark amber brown, armed with smooth, bluntly pointed conical tentacles; there is a supralateral row from the second thoracic to the ninth abdominal segments inclusive, those of the first abdominal, and still more those of the thoracic segments, a little more closely approximated than the others; they vary in size, the third abdominal being slightly smaller than the second, fourth, fifth and sixth abdominal, which in their turn are scarcely more than half as long as the remaining; they are all of an orange color, the longest infuscated at the tip, and all bearing a few scattered, short, fine, black hairs most abundant apically; there is an obliquely ascending laterostigmatal row of similar but duller colored tentacles on the thoracic and first abdominal segments, that of the first thoracic segment more slenderly tapering than any others on the body and more than twice as long as the others which slightly decrease in size posteriorly; there is also an infrastigmatal tubercle (similar to the laterostigmatal one of the second thoracic segment) on the second abdominal segment, which is so nearly stigmatal as to slightly displace the spiracle, and a row of small, equal, stigmato-ventral tubercles on the third to eighth abdominal segments at the base of the prolegs; legs black; prolegs of the color of the body; spiracles minute blackish; a very few short, black hairs are scattered over the body. Prothoracic shield blackish castaneous, shining, three times as broad as long, the lateral edges equally rounded; lips of osmateria very dull orange; anal plate minute, black, bristling with black hairs. Length, 9 mm.; breadth, 2 mm.; length of long tentacles, 1.2 mm.

Third stage (76: 21; 80: 3). In this stage the caterpillar does not appear to differ from the preceding excepting in the accentuation of the distinctions between different parts of the body; the body color grows a little darker as do most of the tubercles, but those of the supralateral series become a brighter orange, excepting upon the sixth to ninth abdominal segments; the difference in the size of all the filaments is also increased and those of the first thoracic and sixth abdominal segments become slightly curved. The caterpillars have now reached a length of 11 mm. and a breadth of 2 mm., while the long anterior tentacles measure 2.5 mm. and the supralateral tentacles of the sixth abdominal segment, .85 mm.

Fourth stage (80: 4). This agrees very closely with the succeeding stage, the only noticeable difference being that a suprastigmatal row of coral red spots on the anterior edges of the fourth to seventh abdominal segments appears. Length, 26 mm.

Last stage (76: 13, 20). Head (80: 5) dull dead black, bristling with short, black, stiff hairs; mandibles piceous; other mouth parts and antennae black with the bases of the joints pale. Body blackish purple with a velvety aspect or dark olivaceous maroon, darkest in the middle of the segments; tubercles of the same color as the body excepting most of those of the supralateral series which are generally orange but with the same short black hairs found on the dark tubercles; the last pair of tubercles of this

series, however, and sometimes the first one, of the body color, occasionally with a tinge of orange or ferruginous; and those of the seventh and eighth abdominal segments are orange only at base, or on basal half and then generally dull in tint while the rest is of the body color; the suprastigmatal tubercle of the first abdominal segment is also more or less bright orange and the inner edges of the lips of the osmateria the same. The tapering tentacles of the first thoracic segment are nearly twice as long as any of the others and are directed outward, upward and a little forward, the apical half curving a little forward and outward, those of the same row behind it and the substigmatal tubercles are directed outward and curve apically downward, while the long ones of the supralateral row are directed outward and upward and in addition those of the seventh segment curve forward, and those of the ninth backward. Prolegs of the color of the body, or duskier; legs nearly piceous. Spiracles piceous. Last segment of body darker than the rest and the first thoracic segment with a black dorsal shield; osmateria of moderate size, dividing from base, tapering, of a pale orange color, a little olivaceous especially at base, the branches 7 mm. long, bent at a little less than a right angle, the anterior lip of the osmaterial opening orange. Length of body, 48-55 mm.; breadth at first thoracic segment, 5-6 mm.; at second abdominal segment, 7.5-9 mm.; breadth of head, 3.6 mm.; length of tentacle of first segment, 12-15 mm.; of lateral series of third thoracic segment, 5 mm.; of laterodorsal series of same segment, 1 mm.; of ninth abdominal segment, 3.5 mm.

Chrysalis (85: 14-17, 20). Of a rich dead-leaf color, brighter dorsally than ventrally, more or less infuscated, especially upon the prominent portions; the whole surface is also delicately marked in black in creases which run everywhere over the body; on the upper surface of the abdomen they assume a somewhat regular disposition, there being a mediolateral line and one which passes along the sides midway between the ridges in a sinuous course and from which branches run upward and a little backward, two to each segment, the anterior striking the laterodorsal ridge at about the middle of the segment; on the dorsal part is a broad somewhat M-shaped black crease reaching across from one ridge to its opposite. All the ridges are marked with blackish or brownish fuscous and their upper surfaces also tinged with purplish violet, the latter color being especially noticeable on the transverse anterior ridge of the pronotum, the dorsal expansion of the wing cases, the laterodorsal abdominal ridges, and particularly on the entire cremaster above and below. The sides of the mesothorax and first to third abdominal segments are marked with bright yellow, on the second and third abdominal segments more or less obscured by a tawny tinge; the posterior third of the prothorax is also slightly tinged with yellow; a series of triangular fuscous spots forming a mediolateral band with their apices pointing backward reaches from the hinder edge of the mesothorax to that of the third abdominal segment. Length of chrysalis, 26-30.5 mm.; breadth at girth, 8 mm.; at ocellar tubercles, 5.5-6 mm.; at basal wing tubercles, 7.5-9.1 mm.; at alar expansion, 11-12.6 mm.; height at base of abdomen, 8.4 mm.; length of cremaster above, 2 mm.; height of metathoracic crest, 2.25 mm.; of laterodorsal ridge on abdomen, 1.2 mm.

Mr. H. Edwards speaks of the general color of the chrysalis as "grayish stone, mottled with violet and yellow"; but states that he raised some in California early in July which were "pale, but vivid, yellowish green, of a very lively tint over the whole surface, which is covered with minute, black reticulations. The edges of the wing-cases, abdominal tubercles, apex of the mesonotal process and edges of the antennae cases rich purplish brown" (Pac. coast lep., 84).

Distribution (26:6). This butterfly occupies both the Alleghanian and Carolinian faunas, but is absent from much of the northern half of the former and becomes rare at the extreme southern limits of the latter. It is, indeed, common in eastern Florida, being found as far south as Enterprize (Schwarz), and is not rare in most of Texas (Belfrage), but

Dr. Chapman states that it is "rare and accidental" in Apalachicola, Fla., although "abundant in the country above," and Aaron speaks of it as only "moderately common" in southern Texas. It occurs, however, in Mexico in the western portion (Doubleday), at the Rio Verde San Luis (Palmer) and as far south as Cordova (Sallé). Butler says it occurs also in Costa Rica. Westward we find it abundant as far as the great plains; that is, to central Iowa (Osborn, Putnam, Parker) and eastern Kansas, scarce (Snow); but it does not extend beyond them excepting to the southward, where it is reported from New Mexico (Snow) and Arizona (Doll, Morrison); here it extends to the Pacific, stretching again northward along the coast to the neighborhood of San Francisco and as far at least as Sonoma County (H. Edwards, Osten Sacken). In the great intervening area between California and the Mississippi valley it appears to be totally absent. The northern limit of its abundance in eastern America is beyond the annual isotherm of 55°, and it is found sparingly as far as that of 50°; the northernmost localities from which it has been reported are: Grinnell and Keokuk, Io., "rare" (Parker), Wisconsin, "not uncommon" (Hoy), near Chicago, Ill. (Mus. Chic. acad. sc.), Rockport (Kirtland) and Cleveland, Ohio "common" (Kirkpatrick), "scarce" (Ison); "has been taken in different parts of Ontario; usually rare; one summer abundant near Hamilton" (Saunders); shore of Lake Ontario (Petit); about Toronto and at Woodstock (Saunders); Long Island (Graef, Akhurst), Staten Island (Davis), and Newburgh, N. Y. (Edwards).

In these exceptionally northern localities the butterflies occasionally appear in considerable numbers. Thus Bethune writes (Can. nat., iii: 320) that about 1858 they appeared in Flamboro near Hamilton, Canada, "in countless numbers about the lilac trees as long as they continued in blossom and then suddenly disappeared. They lasted from the 7th to the 18th of June, but very few appearing after that date." Since then, according to Mr. Saunders, they have rarely been seen, two or three only having been taken at Woodstock about 1865, "several specimens" about Toronto in twenty odd years and one at Ridgway in 1880.

Specimens were found by Dr. Dean on the summit of Big Butte, one of the Iron or Smoky Mountains, Tenn., 5000 feet above the sea (Uhler).

In New England it is of course very scarce. Rarely has more than a single specimen been taken during a season excepting near New Haven, Conn., where the species is "apparently not very uncommon" (Smith). It has also been found in Branford (Hammer t. Faxon) and Farmington, Conn. (Norton), and in one or two instances about Boston, and is found nearly every year as far north as Beverly, Mass. At Cambridge it was first taken by Dr. Harris, who reared specimens in 1840 from caterpillars found in the Botanic Garden. The original manuscript of a report made at the time to the Harvard Natural History Society by T. W. Higginson,

then a student of Harvard College and curator of entomology in this college society, has been given me, by which it appears that two broods of caterpillars were found at that time, only one of which was secured by Dr. Harris, the other being destroyed by the gardener. The writer conjectures that the eggs were laid by "some stray individuals driven here from New Haven by violent winds; possibly this is the original 'beautiful butterfly come from Connecticut';" but he adds that a specimen was caught earlier in the same summer a few miles distant at Watertown. Dr. Harris remarks (Entom. corresp., 147) that, "*Aristolochia siphon* grows wild in the woods about New Haven, which is the nearest locality to Cambridge of this genus of plants. It is possible that *philenor* may be found there and from thence an impregnated female may have migrated, or may have been carried by the winds to this place." Dr. Asa Gray, however, writes that "*Aristolochia siphon* does not grow wild in New England at all. It is sparingly planted and is hardy throughout all or most of New England. Its proper habitat is in and along the Alleghanies and it is indigenous north to the middle of Pennsylvania,"—just where this butterfly ceases to be common. For several years I have examined the same plant at the Botanic Garden without success, but caterpillars have occasionally appeared there since 1840. A fresh specimen of the butterfly was taken on the Watertown side of Mt. Auburn (Cambridge) in 1869 by Mr. Davenport (Atkinson); one specimen was taken and another seen in Walpole, N. H., in 1870 by Mr. Smith.

Abundance and haunts. This is a very common butterfly in the south, frequenting blossoms and damp spots in roads. According to Doubleday, it frequents the flowers of *Asimina grandiflora*, and Abbot speaks of its fondness for those of plum and peach. "One of the most numerous of the many species that gaily flutter their brilliant wings in the burning beams of almost vertical noon and contribute so much to the life and beauty of nature by their presence," says Gosse, "is the blue swallow-tail. . . . I have taken these fluttering about the heads of the orange milk weed, their abdomens filled almost to bursting with the yellow nectar of these flowers, and so distended that the divisions of the segments are obliterated, and are discernible only by being bare of the scaly plumage. When in this state, they seem unwilling to fly, but either remain at rest or run to and fro over the blossoms, keeping their hind wings in a vibratory, quivering motion." (Lett. Alab., 77.) Rev. Mr. Matin of Huntsville, east central Texas, in sending, March 5, 1874, a specimen of this butterfly to Mr. Riley, speaks of "the multitudinous swarms . . . now flying about and literally *filling* the peach trees, now in full bloom. . . . I never saw so many butterflies of any one kind as there now are of this. The little yellow fellows that are seen in the summer around mud puddles in the road are few in comparison" (Am. nat., xv: 329).

Oviposition. Mr. W. H. Edwards thus describes the action of the female while laying her eggs: "After fluttering from one leaf to another she fixed upon a leaflet at the extremity of the stem, stood with legs stretched straight beneath her and bending down the end of the abdomen to the stem of the leaflet deposited an egg upon it; she continued to deposit the eggs one after another in straight rows, with intervals between the eggs and between the rows equal to the diameter of the egg, and in so doing curved the abdomen quite around to the opposite side of the stem until the latter was half encircled with eggs; in all she laid 12 in 3 rows of 4 each. I climbed by a ladder to within a foot of her but she showed no apprehension; on another stem I found 18 eggs; the eggs were attached to the stem by a substance of a deeper red than the egg and which looked, under a glass, like wax." Mr. Edwards elsewhere says they are "laid in one or two rows of from five to ten in the row, on the under side of the leaves and are not close together, but separated by narrow spaces."

Mr. Riley has sent me one cluster laid on the upper side of a leaf, two straight rows of three each, as closely packed as possible. In another instance three eggs sent me by Mr. Edwards, laid on a *Polygonum*, were attached to the stalk in a single row just below the base of a leaf; and in a bunch found by me at Beverly in 1887, on an *Aristolochia* in the grounds of Mr. Jackson that is attacked nearly every year, thirty-two eggs were arranged along the upper surface and sides of a tendril (66:8), the under surface of the tendril being bare; they formed about three rather irregular rows, the middle row tolerably straight and most of the eggs touching their neighbors; it is evident, however, that some of the middle row were laid after some of those in the outside rows had been deposited, as the latter were occasionally covered in part by the former. The eggs hatch in from seven to nine days.

Food plants. This caterpillar feeds mainly on *Aristolochia*; in the south it is commonly found on the Virginia snake root, *A. serpentaria*; in the middle and northern states more often on the Dutchman's pipe, *A. siphon*. According to Riley it also feeds on *Asarum canadense*, also belonging to the *Aristolochiaceae*; and Edwards found the butterfly laying eggs on a *Polygonum*, probably *P. convolvulus*, the black bind weed, belonging to a neighboring family.

Habits of the caterpillar. The young caterpillars do not devour the shell of the egg more than is necessary for emergence, and on hatching "betake themselves to the edge of the leaf and ranging themselves at right angles to this, side by side, feed after the manner of large *Bombycidae*" (Edwards). One which I separated from its brethren and placed upon a leaf apart, immediately after hatching, retired after feeding to near the centre of the upper surface of the leaf, and returned to the edge to feed, eating the leaf from the upper surface as far as the matted hairs of the

under surface, which were left. In so doing it ate a curved channel or furrow from the edge of the leaf inwards and toward the base. Shortly afterward it crawled to the under surface and stationed itself there in a similar way, now eating entirely through the leaf. I placed it with a companion upon the upper surface of another leaf, and they at once travelled to the under side and there remained resting side by side, head to head or head to tail indifferently. I transferred them again just before the second moult to the upper surface of a new leaf where they remained throughout the third stage, eating while extended at full length on the broad side of the leaf, though occasionally, in the early part of this stage, they would feed at the edge, resting upon the same; in the latter part of it they would hardly have been able to do so from their weight. For when travelling over the broad surfaces on which they move, they cover them with zigzag lines of silk, and as Harris says "seem unable to crawl or hold on without this precaution, for when placed on a fresh leaf the least motion causes them to fall off." But this is true at almost any time, for the amount of silk they spin is too slight to give them a strong attachment. Edwards says (Can. ent., xiii: 13) "they are very active in their movements, far more so than any other of our [papilionid] larvae and can travel with great rapidity"; yet they are rather slow eaters. The front filaments are freely movable, and when travelling the caterpillars keep them in constant motion up and down, generally alternating through an angle of about 25° , in the downward movement just not reaching the surface on which they are travelling. During their fourth stage I noticed that when disturbed they had a curious habit, not before observed, of tapping on the leaf repeatedly though not rapidly with the anterior pair of legs, not simultaneously but one at a time.

Their first use of the osmateria was at the very beginning of the second stage, before eating anything, when under provocation I caused them to be thrust out. When about to moult they could not be induced to use them; possibly they are powerless to do so. When full grown, I found it difficult to persuade them to display these organs; it was only through very rough treatment that I could do so and in one instance I was unable by the very roughest means to produce the slightest effect. When they were protruded the odor was hardly perceptible, and not altogether disagreeable, though difficult to describe.

Although strictly gregarious in earliest life and semi-gregarious afterward, when full grown they distribute themselves anywhere over the foliage, doing, according to Riley, great damage in Missouri to the ornamental climbing plants on which they live; in one instance he "found the vines literally denuded, for there was not a whole leaf upon them, those that were not entirely eaten off down to the stem being riddled with different sized holes" (Rep. ins. Mo., ii: 116-118). There could be no

difficulty in preventing this devastation by destroying the young caterpillars as soon as any marks of their destructive propensities are seen, for they are then clustered in companies and easily discovered.

Harris remarks that the young caterpillars "before their first moulting, closely resemble in form and in their tubercles, the figures of the larva of *Ornithoptera helicaon*. . . . After the first moulting, the first pair of tubercles increase in length, and become proportionally much longer than the others, and the body itself becomes more elongated."

Life history. In the north the insect is double brooded and appears to hibernate as a butterfly. Still the earliest record of its appearance is toward the middle of May; in central California the butterfly appears by the first of April; in the south early in March, and not improbably it is polygoneutic even as far north as Missouri. In the middle states the eggs are laid at the end of May and hatch in from seven to nine days. In the south caterpillars of the first brood are matured by the end of April and disclose the butterflies in from ten to fourteen days (Abbot). In California the caterpillars of this brood change to chrysalis all through May and June, and the chrysalis state lasts three weeks or a little more, occasionally a little less (H. Edwards). In the northeastern states young and full grown caterpillars may be found in the middle of June, and the first butterflies from chrysalis appear in July and lay their eggs the latter part of the month; the young caterpillars may be found early in August and generally attain maturity by the last week in August; the chrysalids hang from twenty-four to twenty-seven days, so that the hibernating butterflies make their appearance during the last week of September. With us the caterpillar state lasts from three to four weeks, but is very much prolonged late in the season by cold weather. In West Virginia, according to Mr. Edwards, it lasts but a fortnight or a little more, and the chrysalis state is of about the same duration,—a peculiar point in the history of this butterfly everywhere. Mr. W. H. Edwards thinks there are many broods in West Virginia from "early spring to frosts." Mr. H. Edwards says there are only two broods in central California, the last of May and in August, and states that he had two living chrysalids on October 6, so that he thinks it hibernates in that stage; but with us, to judge from meagre statistics, late chrysalids always give the butterfly the same season. I have had them appear as late as September 23. From southern eggs I have had, in Cambridge, living caterpillars as late as the end of October.

Flight, posture, etc. The fondness of this butterfly for flowers has already been alluded to. The pollinia of orchids may often be found adhering to them. I once found one attached to the tip of one of the fore legs, where the butterfly had carelessly put his foot in his own pot of honey. They are usually attached to the naked eyes, where these come in contact with the rostellum in probing the depths of a flower, and Aaron

states (Can. ent., ix : 200) that a full third of a hundred specimens examined by him for the purpose showed the eyes smeared with a cluster of such pollinia, from three to forty in number.

Doubleday describes the flights of this butterfly as rather low and not very powerful. When hanging from a horizontal support, while the wings are drying after eclosion, the legs are bent at the femoro-tibial articulation to a noticeable amount, showing considerable muscular power at this early and flaccid period; the body hangs at a general angle of about 50° with the support, the abdomen with a sigmoid curve, its tip horizontal; the antennae have the curve they ultimately retain, are horizontally extended, and divaricate about 110° : but if disturbed they will bring them together a little, so as to be at right angles with each other.

This butterfly appears to be very tenacious of life; at least, in one instance, a male just emerged was put for fully half an hour in a strong cyanide bottle and then stretched; three days later it was found to be alive.

Edwards states that the butterfly has a strong and disagreeable scent, but does not state whether it is confined to either sex.

As is well known, the inner margin of the hind wing of the male is reflexed (45 : 4, 5) and conceals androconia. On artificially raising and lowering the abdomen of a fresh specimen, this fold opened and shut, especially at the end nearest the base of the abdomen, by which it appears that the opening and closing of the same is under the control of the insect. Fritz Müller, observing this same fold in other swallow-tails, remarked that it could be expanded "by moving the wings strongly in a forward direction," and in some species he has discovered, not always, however, connected with this reflexed margin, "a very strong odor." In the single opportunity which I had, after reading Müller's notice, of examining a living male fresh from the chrysalis, I carefully removed the androconia from this patch by scraping it with a knife, thereby bruising them and increasing the chance of odor, but was unable to perceive the very slightest, from the bruised scales, the fold or the whole creature.

Experiments with cold. Mr. W. H. Edwards once placed nine chrysalids, at from six to thirty-six hours old, on ice and left them there for twenty-three days. Only one survived the test, and this gave the butterfly unchanged; he does not say how long the chrysalis stage was lengthened.

Desiderata. The seasons of this insect in its various stages, whether in the north or south, are very imperfectly defined. We do not even know satisfactorily how it passes the winter. At what latitudinal line do the two broods change to more? The disparity in the reported duration of the chrysalis needs explanation; and neither the flight nor the postures of the butterfly have been adequately described. Does it enjoy any special im-

munity? Not a single parasite is known, and it remains to be investigated whether it escapes that arch enemy of our swallow-tail caterpillars, *Trogus exesorius*. It would be worth while to bring the two into relation and watch the result.

LIST OF ILLUSTRATIONS.—*LAERTIAS PHILENOR*.

- | <i>General.</i> | <i>Imago.</i> |
|--|--|
| Pl. 26, fig. 6. Distribution in North America. | Pl. 16, fig. 3. Upper surface. |
| <i>Egg.</i> | 85: 24, 25. Male abdominal appendages. |
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| <i>Caterpillar.</i> | 46: 4. The fold, opened and highly magnified. |
| Pl. 72, figs. 7. Caterpillar at birth. | 5. The same in cross section. |
| 76: 13, 20. Full grown caterpillars. | 46: 42. Androconium. |
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| 20. Side view. | |

IPHICLIDES HÜBNER.

Ipheclides Hübn., Verz. bek. schmett., 82 (1816).

Podalirius Swains., Zool. Ill., II: 105 (1832-1833).

Papilio (pars) Auctorum.

Type.—*Papilio podalirius*.

Some to the sun their insect wings unfold,
Waft on the breeze, or sink in clouds of gold;
Transparent forms, too fine for mortal sight,
Their fluid bodies half dissolv'd in light;
Loose to the wind their airy garments flew,
Thin glittering textures of the filmy dew,
Dipt in the richest tincture of the skies,
Where light disports in ever mingling dyes,
While every beam new transient colours flings,
Colours that change whene'er they wave their wings.

POPE.—*Rape of the Lock*.

Imago (56: 9). Head large, profusely clothed with very long, erect, equal hairs. Front somewhat tumid, especially below, on the lower half projecting a little beyond the front of the eyes and increasingly so downward; sides considerably sunken below the eyes, particularly above; next to the border, and closer to it than in the other genera, a slight sulcation directed toward the outer edge of the antennae; below the antennae, the front is of about equal height and breadth, and perhaps rather broader than the eyes on a front view; upper border projecting rather broadly between the antennae; lower border strongly rounded. Vertex somewhat tumid at the sides, but little in the middle, forming a straight, rather broad, transverse ridge, depressed in the middle, whose ends are swollen and thrust considerably forward; portion in front of the ridge slightly tumid and separated from the ridge by a slight sulcation, and from the front by a similar one. Eyes very large and very full, naked. Antennae inserted with their anterior half in the middle of the summit, separated by a space nearly equal to the diameter of the second antennal joint; scarcely longer than the abdomen, composed of forty-one joints, thickened a little, and, excepting on the club, slightly expanded on the inner side at their tips, the terminal ten or eleven forming

the depressed cylindrical club, which is more than three times as broad as the stalk, not more than two and a half times longer than broad, subspatulate, well rounded, largest on the fourth joint from the tip, the last two joints facing somewhat outward and forming a broadly rounded apex. Palpi very minute, slender, reaching the middle of the front of the eye, rather thinly fringed with very long, erect hairs.

Prothoracic lobes obsolete. Patagia small, slightly arched, flat, the base circular, bearing a posterior lobe, whose apex is scarcely narrower than its base, one-third as broad as the base, very slightly curved outward, the tip bluntly pointed.

Fore wings (41:1) nearly twice as long as broad, the costal margin a very little bowed, but rather flattened along the middle, the outer border scarcely concave, but at the two extremities receding a little to round off the angle, the general direction at an angle of 85° with the general course of the costal margin; inner border straight. First superior subcostal branch arising somewhat beyond the middle of the outer two-thirds of the upper margin of the cell; second scarcely more than half way from here to the apex of the cell; third at the apex; and fourth at a little more than two-fifths way from the apex of the cell to the outer margin of the wing. Cell three-fifths the length of the wing, and fully three and one-half times longer than broad. At the origin of the fourth median branch the main vein is raised above the continuation of its basal half by slightly more than the width of the last median interspace at its base. Cross vein connecting median and submedian near the base directed straight downward.

Hind wings with the costal margin considerably and roundly expanded next the base, beyond very slightly convex; outer margin very strongly crenulate, divided by the tail at the tip of the upper median nervule into two portions; the upper has a general straight direction, at an angle of about 110° with the costal border, the angle rounded off like the crenulations; the tail is exceedingly long, equal, slender, bluntly rounded at tip, as long as the normal portion of the upper median nervule; the lower portion is also straight and bent at right angles to it; just beyond the lowest median nervule it is rounded off and recedes abruptly, to the distance of an interspace and a half, and then proceeds on its course; the inner angle is rounded off and the inner border nearly straight. Subcostal nervure very strongly curved between the bases of the first and second nervures; vein closing the cell considerably shorter than the distance between the bases of the second and third median nervures.

Fore tarsi slightly longer than the femora and more than a third longer than the tibiae; middle femora somewhat longer than the tarsi and more than a third longer than the tibiae; hind femora scarcely shorter than the fore femora and five-sixths the length of the middle pair; middle tarsi a little shorter than the front tarsi and about four-fifths the length of the hinder pair. Femora fringed all over, excepting above, with a thin, rather long brush of delicate hairs. Tibiae armed beneath on either side with a row of distant, not very long but slender spines, the inner row forking into two, directed toward either side of the base of the inner spur; above, on either side, with similar single rows; spurs rather short and slender, the inner scarcely longer. First joint of tarsi scarcely equalling the three succeeding together, the second, third and fifth about equal, the fourth a very little smaller, all armed beneath on either side with a row of frequent, rather long and very slender spines, the apical ones of each joint a little longer and stouter; above with much more infrequent and much slenderer, smaller spines, vaguely arranged in four rows; claws long and very slender, delicately beveled at the extreme base below, a little compressed, straight, and equal until close to the tip, which tapers to a delicate point and is curved a little downward; paronychial and pulvilli wanting.

Eighth abdominal segment of male produced mesially above to a very broad, depressed, subquadrate, broadly truncate tooth, bearing centrally an equally long but slender spine, bifid and only slightly declinant at tip, the middle prong the longer. Valves tumid, ovate, pretty regularly rounded, longer than broad, each bearing within, subparallel to the outer margin, a denticulate ridge and a long, central spine, directed towards its counterpart.

Egg. Subspherical, about a fourth broader than high, the upper curve slightly depressed above over a broad area, the base broadly truncate, fully as broad as the height. Surface uniformly broken into faint, minute, polygonal cells.

Caterpillar at birth. Head almost if not quite wholly free, transversely subquadrate, rounded a little above and rather flattened in front, broadest below. First thoracic segment much larger than the head, the body increasing in size to the third thoracic segment, beyond which it tapers, at first more rapidly than afterwards, so that the shape is much as in maturity; the body is cylindrical, not angulated, and is furnished with a laterodorsal series of tubercles, scarcely higher than broad, one to a segment on the third thoracic and first to tenth abdominal segments; the first and last three are largest and all are provided with three or four rather long hairs, the central longest, all forked near the tip and the forks nearly at right angles to each other; there is a similar lateral series from the second thoracic to the ninth abdominal segments inclusive, bearing only a single bristle, also forked; and a suprastigmatal series on the same segments bearing several subequal simple bristles; similar papillae with simple hairs occur on the second thoracic segment where they are subdorsal and small, and on the first thoracic at the outer limits of the osmaterial mouth where they are conspicuous and compound; and there is also an infrastigmatal series on all the segments of small warts bearing simple hairs. Legs and prolegs of medium length.

Mature caterpillar. Head moderately large, subquadrate, domed, subtruncate below, broadest just below the middle, the sutures scarcely depressed except at summit and there considerably, the front appressed, scarcely convex, the cheeks full below, the surface smooth and glistening, very sparsely furnished with minute hairs on minute tubercles. Triangle almost as broad as high, but reaching half way up the front. Antennae with the first joint very broad and short, low and conical, the second a mere ring, the third cylindrical, slender, four times as long as broad, with an apical tapering arcuate bristle half as long again, the fourth minute. Ocelli six in number, five in a cluster, of which four are equidistant on the strongly curving arc of a quadrant of which the fifth is the centre, while the sixth, slightly smaller, lies on the inferior aspect of the head as far below the cluster as the height of the cluster itself. Clypeus scarcely emarginate. Labrum of moderate size, strongly and roundly and rectangularly emarginate. Mandibles massive with entire convex edge. Last joint of maxillary palpi minute, the penultimate larger than usual, cylindrical, nearly twice as long as broad.

Body bulky, bloated and tuberculate anteriorly on the second and third thoracic and first abdominal segments, largest on the third thoracic, again enlarged a very little on the eighth and ninth abdominal segments, the body between gently tapering with tolerably well marked incisures and smooth. The tubercles, which are coriaceous, are confined to slightly elevated, transverse ridges on the third thoracic and first abdominal segments; and similar ridges but hardly tuberculate and much less conspicuous are found on the dorsal portion of the fifth and sixth and at the posterior edge of the eighth and ninth abdominal segments. The body is practically naked, but has microscopic hairs sparsely scattered and is adorned with variegated patches and blotches and saddles of darker and lighter colors. Spiracles moderate, oblong ovate, with sharp but stout bounding ridges. Legs small, the front pair much smaller than the others, the claws with a large basal tubercle. Prolegs very stout and fleshy, hardly tapering.

Chrysalis. Very compact, not more than three times as long as broad; in general, the anterior extremity subtruncate, the posterior conical. Viewed laterally the chrysalis is nearly straight, slightly curved downward posteriorly, the anterior half with almost perfectly parallel straight upper and under surfaces, reaching from just behind the ocellar and mesonotal processes to the end of the third abdominal segment; in front the anterior extremity is nearly straight and forms only a little less than a right angle with the inferior surface and as much more than a right angle with the superior; but the trigonal mesonotal tubercle is produced forward and upward so as to disturb the angle at this point, and the ocellar prominences to a less degree at their angle. Viewed from above the ocellar prominences project forward and outward with a deep

and rounded excision between them, the head and thorax as far as the basal wing tubercle widen with a gradual and regular curve, beyond which the body broadens still to a very slight degree as far as the end of the third abdominal segment, and then, almost as gradually, diminishes to the narrow truncate tip. The ocellar tubercles are small, triquetral, slightly compressed, the narrowest face inferior, the superior ridge carinate. The mesonotal tubercle is larger, rather prominent, triquetral, the narrowest face posterior, all the ridges carinate; the basal wing tubercle is compressed and carinate in a direction subparallel to the lateral carinae of the mesonotal tubercle. These lateral carinae continue as distinct carinae to the extreme base of the inferior wing-cases, the narrow belt of which they then traverse with almost equal distinctness to the extremity of the third abdominal segment, then bend in their course and run straight to the lower lateral angles of the cremaster; in this latter portion of their course they are less distinct than in the other and sometimes subobsolete. The anterior carina of the mesonotal tubercle also extends as a distinct carina as far as the head, and there is a dorsal carina over the remainder of the thorax, obsolete on the metathorax. All these carinae are distinct and sharp, and a similar distinct and sharp carina is found over the entire abdomen running with a broad arcuation from the upper lateral angles of the cremaster to the metathorax; here and at the posterior extremity they are laterodorsal, but upon the middle of the abdomen they are supralateral and they cross the metathorax so obliquely as to be subdorsal at its anterior edge. Fainter and lower carinae are also found running from the basal wing tubercle over the wing, marking the course of the median nervure, and above connecting the same tubercle with the anterior base of the mesonotal tubercle. There is a series of oblique and sometimes arcuate carinae on the sides of the second to seventh abdominal segments, midway between the carinae already mentioned and the spiracles, running on each segment from above backward and downward. The anterior margins of the same abdominal segments are also carinate to a greater or less degree, marking on the movable segments the limit to which the segment can be closed, and there is on all abdominal segments just before the posterior border, most distinct upon those bearing spiracles, a thread-like carina. Cremaster tetraquetral, depressed, tapering, all the four ridges carinate. The hooklets occupy only the apical field, the stalk slender, cylindrical, straight only on the basal half, beyond strongly curved, enlarging, gradually at first, apically into a transverse, appressed, recurved flange three times as wide as the stalk, and at the apically recurved angles triangularly produced. Spiracles oblong obovate, crateriform, the edges distinct and carinate; the prothoracic spiracle semilunar, of varying height. Surface of body delicately corrugate and more minutely punctate with greater or less distinctness. Tongue case reaching exactly the end of the superior wings; the antennae falling just short of this.

This genus of swallow-tails is very numerous in species and has its home in tropical America. Two species, however, are known from Europe and western Asia between the 30th and 55th parallels. In America it is very abundant in the Antilles, Central America and the northern coast of South America but has not been found south of the tropics, while in North America, at least in the eastern half of the continent, one species reaches 40° N. Lat. and has been found on the confines of New England.

The butterflies are very elegant in form; they are among the smallest of swallow-tails and merit that appellation more than others, each hind wing being provided with a single appendage, often of excessive length. Their wings are yellow or greenish yellow but often more than half black, being heavily bordered and profusely barred with transverse, tapering

stripes, often traversing both wings but most abundant in the cell of the fore wings; the hind wings generally have a red spot or ocellus at the anal angle and the under surface differs from the upper less than usual, even upon the outer half of the hind wings. The antennae have a strongly curved club and are shorter than in the other New England genera. They are also peculiar for the shortness of the legs and particularly of the middle and hind tibiae and the tarsi of the middle leg.

The insects are many brooded and hibernate as chrysalids. The earlier and late generations of those that are best known differ from each other and one at least of the species is polymorphic and presents a remarkable history which will be found in detail below. The butterflies are generally very numerous in individuals; "they all frequent the open country. The tropical species congregate in immense numbers to imbibe the moisture on the humid margins of lakes, rivers and muddy places generally" (Bates).

They "have a low rapid, unsteady flight, generally amongst the scattered brushwood on the skirts of forests or in old neglected plantations; they take long circuits, returning after the lapse of a few minutes in the same direction and often in precisely the same track they have just passed over" (Doubleday).

The European *I. podalirius*, according to Meyer Dir, is found in Switzerland to the height of 3000 feet and is rather an inhabitant of hilly and mountainous regions than of the lowlands; it has a magnificent sailing flight.

The eggs are laid singly upon the upper surfaces of leaves, and hatch in a week or less; the caterpillars feed separately, principally on Anonaceae and Rosaceae and make no attempt at concealment; they are extremely offensive from the odor emitted by the osmateria, although Lacordaire says that *I. podalirius* exhales an odor of musk (Ann. soc. ent. France, ii: 383). The chrysalids hang for about a fortnight.

The metamorphoses of several species are known. The eggs are green in color, spheroid in shape, about one millimetre high, with no secretion upon them. The caterpillars at birth are cylindrical but largest in front and bear several rows of warts, larger in front and behind than in the middle, each of which bristles with a number of diverging needles, some of which are widely forked at tip, a remarkable peculiarity rarely found among arthropods.* The mature caterpillars are naked, largest at the hindmost thoracic segment and taper toward each end; their osmateria are of unusual length and their body is ornamented with transverse stripes or rows of small spots, the most conspicuous of which are on the anterior portion of each segment.

*Some Sphingidae in their earliest stage have the caudal horn bifid at tip. Reaumur figures a sawfly larvae with bifid spines, some carboniferous myriapods are remarkable

for this feature, and similar structures are known in the subfamily Diaspidinae among Coccidae, and in the early stages of certain Crustacea.

The chrysalids are remarkable among North American types for their short, blunt, compact form and for the very slight advance of the ocellar prominences; anteriorly indeed they have a subtruncate appearance while behind the posterior half of the abdomen is conical; slight, scarcely raised ridges course longitudinally and obliquely over the body, which is more uniform in color than in any other of our genera, and usually of a pea-green hue.

EXCURSUS XLVIII.—THE BUTTERFLY IN ANCIENT LITERATURE AND ART.* BY C. H. B.

The butterfly the ancient Grecians made
The soul's fair emblem, and its only name—
But of the soul, escaped the slavish trade
Of mortal life!—For in this earthly frame
Our's is the reptile's lot, much toil, much blame,
Manifold motions making little speed,
And to deform and kill the things whereon we feed.
COLERIDGE.—*Psyche*

THE earliest known mention of the butterfly is in a Chinese story belonging to the sixth century before Christ. In it is related how Tschwang-sang dreamed that he was a butterfly, and was told by his teacher, Lao-tze, in explanation, that at the time of chaos he had been a white butterfly whose soul, after its body had been swallowed by the phoenix, lived on and appeared anew on earth in the form of Tschwang-sang." (Stephani.)

In Greek literature† the butterfly first appears in the writings of Aristotle, who says that butterflies are born from caterpillars, caterpillars from cabbage leaves; he describes the chrysalis, noting the fact that it moves when touched and also speaks of the egg, not however as an egg, but as a hard substance, liquid within, which is produced by butterflies; he also mentions the antennae. Aristotle speaks of transformations in other insects, but Theophrastus in one place says such changes are seen in butterflies only. Plutarch speaks briefly of this three-fold form of life in caterpillar,

* This sketch is taken mainly from a detailed account of the butterfly, given by Stephani in the *Compte-rendu* of the St. Petersburg Archeological Commission. He has been for the most part closely followed, but, as it was necessary to condense his descriptions, I have found it impracticable to acknowledge by quotation marks my indebtedness to him. For the *Psyche*-myth I have used Collignon's interesting essay in the same way. My thanks

are also due to all who have kindly helped me by advice or explanations. C. H. B.

† The butterfly apparently does not occur in the Egyptian hieroglyphs, "but in a mural painting in the British Museum, obtained from Thebes, there may be seen almost a plague of butterflies." This painting has been assigned to the eighteenth or nineteenth dynasty (A. S. Murray, *Academy*, xviii: 14).

chrysalis and butterfly. In Nicander the *φάλαυα* is mentioned which "flutters round the lamp" and the scholiasts annotate "the *φάλαυα* is called *ψυχή* with us; *φάλαυα* is a Rhodian name." Hesychius cautiously defines a chrysalis as sprung "some say" from a caterpillar. The words *ψυχή* and *papilio* like the German *schmetterling*, mean moth as well as butterfly, and Ovid's "*papilione*" in the following lines (Ov. M., 15, 376) is a moth:—

Quaeque solent canis frondes intexere filis
Agrestes tineae, res observata colonis,
Ferali mutant cum papilione figuram.

Böttiger translates "*ferali papilione*" as "*selbst sich sengendem schmetterling*," suicidal butterfly one might say. Similar lines attributed to Lactantius describe cocoons seen among rocks. (De Phoeo, 107):—

Ac velut agrestes, cum filo ad saxa tenentur,
Mutari tineae papilione solent.

Pliny mentions the "*papilio*" seven times in his Natural History, meaning by the word in four of these places moth. He gives an interesting description of the silk-worm and the formation of its cocoon, of the beehive moth and the means of destroying it, a subject which was treated by Aristotle and Columella before him. A curious passage is that where he says, "the moth (*papilio*) that is seen fluttering about the flame of a lamp is generally reckoned in the number of noxious medicaments; its bad effects are neutralized by the agency of goat's liver." In two of the remaining passages he borrows freely from Aristotle, but he carries the origin of the butterfly back to "the dew, which settles upon the cabbage leaf in spring, and is thickened by the action of the sun." After romance, a bit of fact from the same author is welcome. "There are some who look upon the appearance of the butterfly as the surest sign of spring, because of the extreme delicacy of that insect. In this present year, however, in which I am penning these lines, it has been remarked that the flights of butterflies have been killed three several times by as many returns of the cold." (Bohn's translation.) Tertullian in speaking of different animals as opposed in their nature to different elements says, "In like manner, those creatures are opposite to water, which are in their nature dry and sapless; indeed locusts, butterflies and chameleons rejoice in droughts." (P. Holmes's translation.)

We have seen that the word *ψυχή*, meaning butterfly, first occurs three hundred and fifty years B. C., but *ψυχή*, the soul, is imagined with wings in the time of the Homeric poems; since in Il. xxii: 362, Od., xi: 222, the *ψυχή* is spoken of as flying away. Finally in an epigram by Meleager (Anth. Pal., xii: 132) there is a play upon the double meaning of the word:—

Οὐ σοὶ ταῦτ' ἐβόων, ψυχή, νῆ: Κύπριν, ἀλώσει,
 ὧ δούσεως, ἰξῶ πυκνὰ προσιπταμένη;
 οὐκ ἐβόων; εἶλ' ἐν σε πάγη. τί μῆτιν ἐνὶ δεσμοῖς
 σπαίρεις; αὐτὸς Ἔρως τὰ πτερά σου δέδεκεν,
 καὶ σ' ἐπὶ πῦρ ἔστησε, μύροις δ' ἔρρανε λιπόπνονι,
 δῶκε δὲ διψῶσιν δάκρυα θερμὰ πιεῖν.
 ἂ ψυχὴ βαρύμοχθε, σὺ δ' ἄρτι μὲν ἐκ πυρὸς αἶθρ,
 ἄρτι δ' ἀναψύχεις, πνεῦμ' ἀναλεξαμένη.
 τί κλαίεις; τὸν ἔτεγκτον ὄτ' ἐν κόλποισιν Ἔρωτα
 ἔτρεφες, οὐκ ἦδεις, ὥς ἐπὶ σοὶ τρέφετο;
 οὐκ ἦδεις; ὅν γινώθι καλῶν ἀλλαγμὰ τροφείων,
 πῦρ ἅμα καὶ ψυχρὰν δεξαμένη χιόνα.
 αὐτὴ ταῦθ' εἶλον· φέρε τὸν πόνον. ἄξια πάσχεις
 ὧν ἔδρας, ὅππῃ καιομένη μέλιτι.

Here *ψυχή*, or the human soul, is personified and is suffering for her love to Eros who torments her, but her outward form is that of a butterfly caught fast in birdlime.

The infrequent mention of butterflies by ancient authors contrasts strikingly with the frequency of their appearance in ancient art. "The myth of Psyche," says Collignon, "was consecrated by art nearly four centuries before Apuleius gave it a literary form." Stephani, who thinks that the Psyche myth originated nearly three centuries later, gives the same date, 250 B. C., as that of the first representation of the butterfly in art. "It is seen in a sardonyx-cameo set in a massive gold ring which was found in a grave on the peninsula of Taman in 1877. It represents Eros stretching out his hand to catch a butterfly which flutters before him at a slight distance from the ground." Stephani describes the butterfly in art as: the child of nature; the representative of vital energy common to all objects and having almost always a prophylactic object; a type of the human soul; and, in connection with Eros, Aphrodite and other divinities, a type of the loving human soul. He cites many examples of the first class, the oldest being found in two series of Roman copper coins. In one series the butterfly is seen alone; in the other a bunch of grapes is added to it; they belong to the time of the second Punic war, 218 B. C. A few of the silver coins of Rhodes, on which the butterfly is seen, may be almost as old; but the greater part of them must be assigned to the first or second centuries B. C. Roman gold and silver coins on which butterflies occur belong to the last century B. C.: on a gold denarius issued 19 B. C. a crab is seen which is trying to catch a butterfly with its pincers; on a silver denarius a butterfly is seen sitting on a lituus; there are also other silver denarii on which a butterfly alone is seen.

Engraved stones of the time of the Roman emperors show a butterfly

hovering over a rose, several butterflies poised on an ear of wheat. In a fresco a butterfly is seen fluttering near some strawberries and figs, while from either side a bird approaches. A butterfly on a grape vine, seen on a marble pillar, which must be considered as a funeral monument, belongs to the same class, and so do butterflies that a bird is about to attack; several funeral urns in Montfaucon's *Antiquité Expliquée* show examples of this sort. In a sepulchral cippus of the Villa Borghese a youth is seen surrounded by a monkey, a dog, a bird and a butterfly; the butterfly sits on his right hand, while a second butterfly close by is being devoured by a bird, and a third seems to flutter among the leaves of a shrub. This stone shows us that the butterfly was cherished and tended by boys and girls as a pet.

Examples of the second class, where the butterfly represents vital energy, are seen in precious stones that were worn as amulets. On an amethyst a butterfly is seen sitting on a great human eye; on a carnelian an actor with a mask is seen; on one side of him is a horn of plenty, on the other a butterfly. On seven engraved stones the butterfly is seen in connection with the peacock, whose tail was considered as an emblem of blossoming meadows. In five of these stones, the peacock drives the butterfly, which is attached by a double thread, and in one place two ears of corn are sprouting out of the ground before the bird; in a sixth stone the butterfly carries the great bird on its back. In a Herculaneum fresco a griffin, whose use on amulets is well known, is seen driven by a butterfly. In a tomb lately discovered at Mycenae, little gold disks with butterflies engraved on them were found. The specimens of pottery in this grave were so rude, that it was at first thought to belong to a time 1200 years B. C., but an examination of all its contents makes it seem probable that it is a tomb of Goths who were for a time at Mycenae, who adopted the Greek custom of burying various objects with the dead, and added to their own pottery articles belonging to the spoils they had accumulated. These disks were doubtless attached to garments and served not only the purpose of ornamentation, but had the same prophylactic object that amulets have. A sard on which a butterfly is added to a horn of plenty, a dolphin, a rudder and a globe is doubtless a sailor's amulet.

Among the representations of the butterfly as the type of the human soul, the Capitoline sarcophagus takes the first place. In it Minerva places a clearly defined butterfly on the head of the newly created being. A bronze medallion coined in the time of Antoninus Pius shows the same scene, though the butterfly cannot be clearly distinguished. On funeral monuments a butterfly fluttering over a corpse, a skeleton or a skull is also a type of the soul. An interesting monumental relief which is now in the Palazzo Ricardi in Florence shows a funeral pyre, several persons standing around it, and a butterfly rising above the flames. A terra-cotta slab, now lost,

showed a sepulchral altar on which a fire appeared to burn; over the altar fluttered a butterfly, and before it stood a woman pouring a libation. In connection with this a monument found in Spain has great interest; it bears an inscription beginning

"Haeredibus mando etiam cinere[m] ut . . . volitet meus ebrius papilio." and doubtless means that his heirs were to make a libation at his grave, so that "my butterfly may fly away satiated."

Roman engravers loved to depict philosophers in their meditations on death and the life beyond by representing them with a skull or skeleton before them and a butterfly hovering over it. In a scene on an engraved stone, where, beneath a pig, two Erotes are quarreling over a butterfly, Collignon sees "a very realistic symbol of the spiritual and material life."

The butterfly as a type of the loving human soul pictures oftener the sufferings than the pleasures of love. Böttiger thinks that the Greeks may have fancied the many moths that gathered around the torches of Eros, in festivities celebrated at night, to be souls of maidens in love, burning themselves at the torch of the god of love. In the Villa Maffei two Erotes are seen burning a butterfly over their crossed torches, while their heads are turned away as in grief; this may represent the purification of the soul, through suffering, in love. On a carnelian stone Eros is seen with a hammer and a large nail crucifying a butterfly. In St. Petersburg, "on a sardonyx vase, which is engraved in relief, a bride is seen, while three butterfly scenes show the kingdom of love; in one, Eros pursues a butterfly with his torch, in a second he is driving in a mussel shell drawn by two butterflies, in the third he is shooting with his bow at a butterfly that hovers above" (Böttiger). The pleasures of love are sometimes depicted, as when Eros kisses a butterfly. Occasionally Eros is seen, with hands bound behind, suffering in his turn, and the butterfly is sometimes present, endeavoring, Stephani thinks, to loosen the bands that confine her master. The word $\psi\chi\eta$, like the Latin *anima*, was used as a term of endearment by lovers. Gems and rings given as love tokens often bore the inscription:—

$\psi\chi\eta$, $\kappa\alpha\lambda\eta$, $\psi\chi\eta$, $\psi\chi\eta$ ($\tau\omicron\upsilon$ $\delta\epsilon\iota\nu\alpha$).
Soul, beautiful soul, soul (of so and so).

There are other stones corresponding to these, on which only a butterfly and a person's name are engraved.

The pleasures and sufferings of love are often portrayed by Psyche in maiden form, sometimes with and sometimes without butterfly wings. Collignon says that Psyche is only the last of a series of forms attributed to the soul by Greek artists. In painted vases the different emotions of the soul are expressed by little winged genii, flying by the side of the person whose emotions their attitudes express. A terra-cotta bas-relief found at Milo shows the soul of the gorgon taking the form of an $\epsilon\iota\delta\omega\lambda\omicron\nu$ as it

leaves the body ; it is still half caught in the bust whence it emerges. On painted vases the following types are found : 1. The soul has the form of a little hoplite fluttering near the dead warrior, showing on a small scale the man as he looked when living. 2. It is seen as a bird with a human head, or simply as a bird. An epigram of the anthology shows Plato as an eagle on a tomb looking at the sky. 3. The *εἰδωλον* has only a distant resemblance to a human body ; a little winged, slight figure without consistency, it flutters near the stela of the dead man in many Athenian lekythoi. Byzantine art has continued the tradition of Paganism ; in the Death of the Virgin, seen in all Byzantine churches, Christ holds in his arms the soul of the Virgin, a little white-clad figure, in which a Christian translation of the *εἰδωλον* is easily recognized.

The myth of Psyche is depicted in a long series of statues, engraved stones, funeral bas-reliefs and Christian monuments. Psyche is tortured by Eros, who burns her with his torch ; she stands with her hands bound behind her ; she falls at his feet in a supplicating attitude ; and she is held closely in his embrace. In some funeral bas-reliefs Psyche is associated in the Prometheus-myth with the allegory of birth and death. In the sarcophagus of the Bourbon Museum, she is led up to the newly finished being whom she is to animate, and turns her eyes away from the body extended before her with a gesture of repulsion. On the Capitoline sarcophagus the subjects are arranged with perfect symmetry : in the middle, Prometheus models the figure of a man, whom Athene animates by placing a butterfly upon his head ; further on, the man has just died ; from his extended body the butterfly flies away ; a funeral genius and a veiled woman are present ; in the background are the three fates. On each side of this central part the subject continues symmetrically : on the right, Hermes, conductor of souls, leads Psyche away ; on the left she is reunited to Eros, whom she embraces. A mural fresco in Pompeii, described by Collignon, depicts Psyche with her hands bound behind her back, held by an Eros, another Eros, wearing butterfly wings, burns her with two torches, a third, flying above Psyche, pours upon her the contents of a vase ; both on the left and on the right of the group stands a figure whose face is hidden. Otto Jahn points out the striking analogy between this fresco and the epigram by Meleager, cited above.

Collignon thinks that Psyche represents the immortality of the soul, as a dogma, on Christian monuments, and as a poetic fancy, on some Pagan bas-reliefs. Stephani thinks that the subject was a favorite one on early Christian monuments, because Psyche and Eros are often represented as idealized children, and Christians were to become like children. He also says "no one will doubt that the custom of using the group (that of Eros and Psyche embracing each other) on funeral monuments has been caused by the belief that a corresponding enjoyment in the life beyond would be

insured, through pictures of this sort, to the persons resting in these graves.

We see that the butterfly first appears in classic literature in the fourth century B. C., with no symbolic meaning, but simply as an insect. A hundred years later it is found on coins, alone and in connection with natural objects, still evidently without symbolic meaning. Two hundred years later, about 60 B. C.,* we see in an epigram of Meleager that the butterfly has now become a type of the soul, and "the first works of art in which this idea is clearly to be seen all date from times succeeding the beginning of the Christian era" (Stephani). Stephani calls attention to the fact that the three-fold existence of the butterfly is emphasized by ancient authors, and says that it received the name $\psi\upsilon\chi\eta$, life, because "the ancients believed that vital energy, which they called $\psi\upsilon\chi\eta$, reveals itself in the butterfly, through the three very different forms which it successively takes, much more strikingly than in all other organisms." We notice in many interesting works of art the prophylactic power ascribed to the butterfly; we see its use as a pet name; and we follow it, now symbolizing the soul, through the drama of creation, trial and death; while in some representations of Psyche, the butterfly-winged maiden, we are carried with the released soul to a world where it is reunited to the divine love.

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*Stephani emphasizes this date, in opposing $\psi\upsilon\chi\eta$ because in it was seen a type of the human soul.

IPHICLIDES AJAX.—The zebra swallow-tail.

[The zebra swallow-tail (Gosse); the autumnal ajax (Abbot).]

Papilio caudatus carolinianus Catesb., Nat. hist. Carol., ii: 100, pl. 100 (1743);—Elsenh.-Licht.-Knorr, Catesb. abbild., 100. pl. 100 (1777).

Papilio ajax Linn., Syst. nat., 402 (1758);—Jabl.-Herbst, Natursyst. ins. schmett., iii: 144-146, pl. 42, figs. 5-6 (1788);—Borkh., Eur. schmett., i: 112-113, 249-250 (1788);—Vill., Linn. entom., ii: 2, pl. 4, fig. 1 (1789);—Abb., Draw. ins. Geo. Brit. Mus., vi: 10, figs. 14, 15; xvi: 21, tab. 78 (ca. 1800);—Pal.-Beauv., Ins. Afr. Amér. 70-71, pl. Lep. 2, figs. 2, 2 (1805);—God., encycl. méth., ix: 19, 52-53 (1819);—Chem.-Luc., Encycl. hist. nat., Pap., fig. 1 (1853);—Edw., Butt. N. Am., i (1871); Can. ent., vii: 233-240 (1875); xiv: 26-28 (1882); Psyche, iii: 3-6, 15-19 (1880); Am. nat., xv: 808-809 (1881);—Meld., Ann. mag. nat. hist., (4), xii: 301-307 (1873);—Pagenst., Verh. nat. med. ver. Heidelb., n. f., i: 108-100, 111-112 (1874);—French, Rep. ins. Ill., vii: 139-136 (1878); Butt. east. U. S., 84-86 (1880);—Middl., Rep. ins. Ill., x: 74 (1881);—Grub., Jen. zeitschr. naturw., xvii: 473-474, pl. 7, figs. 16-19 (1884); ibid., xviii: 881 (1884); Pap., iv: 88, 188, pl. 2, figs. 16-19 (1884).

Ipheclides ajax Hübn., Verz. bek. schmett., 82 (1816);—Scudd., Proc. Bost. soc. nat. hist., xvi: 117-119 (1874); Am. nat., viii: 257-266 (1874); Butt., 141, 154, 169-174, 304, figs. 145-147 (1881);—Meld., Ann. mag. nat. hist., (4), xiv: 239-240 (1874).

Papilio protesilaus var. β . Linn., Mus. Lud. Ultr., 209 [Aur., Lep. Mus. Ultr. reg., 30 (1882)] (1764).

Papilio antilochus God., Encycl. méth., ix: 20, 55 (1819).

Figured also by Selg., Samml. amsl. vogel, pl. 67 (1749);—Abb., Draw. ins. Geo. Bost. soc. nat. hist., Oemler coll., pl. 2; Gray coll., pl. 42 (ined.); Glou., Ill. N. A. Lep., pl. 2, fig. 1 (3 figs.); pl. 27, figs. 4, 8; pl. A, fig. 3 (ined.).

IPHICLIDES AJAX MARCELLUS.

The early spring form.

Papilio marcellus Cram., Pap. exot., ii: 4, 149, pl. 98, figs. F. G (1779);—Luc., Pap. 39-40 (1838).

Papilio ajax Smith-Abb., Lep. ins. Geo., i: 7-8, pl. 4 (1797);—Boisd.-LeC., Lép. Amér. sept., 4-8 (1829);—Boisd., Spec. gén., i: 258-259 (1869);—Doubl., Arc. ent., i: 61 (1845);—Dutr., Stett. ent. zeit., xv: 142-143 (1854);—Feld., Spec. Lep. huc. descr., 15, 60 (1864).

Papilio ajax var. *walshii* Edw., Butt. N. A., Pap. i (1871);—Mundt, Can. ent., xv: 87-89 (1883).

Papilio ajax subvar. *abbotti* Edw., Butt. N. A., Pap. i (1871);—Mundt, Can. ent., xv: 87-89 (1883).

IPHICLIDES AJAX TELAMONIDES.

The late spring form.

Papilio telamonides Feld., Spec. Lep. huc. descr., 15, 59-60 (1864); Reise Nov., Lep., i: 60-61 (1865).

Papilio ajax Boisd.-LeC., Lép. amér. sept., pl. 1 (1829).

Papilio ajax var. *telamonides* Edw., Butt. N. A., i, Pap. ii (1871).

IPHICLIDES AJAX AJAX.

The summer form.

Papilio ajax Esp., Eur. schmett., iii: 2-4, pl. 51, fig. 1 (1777).

Princeps hercynicus ajax Hübn., Samml. exot. schmett., i, Lep. i, Pap. ii, Gent. ii, Prin. A. her. a (1806-19).

Ipheclides ajax Hübn., Samml. exot. schmett., text [unpaged] (1806-19).

Papilio marcellus Boisd., Spec. gén., i: 257-258 (1869);—Boisd.-LeC., Lép. amér. sept., 8-11, pl. 2 (1829);—Doubl., Arc. ent., i: 61 (1845);—Feld., Spec. Lep. huc. descr., 15, 59 (1864).

Pathysa marcellus Reak., Proc. ent. soc. Philad., iii: 504 (1865).

Papilio ajax var. *marcellus* Edw., Butt. N. A., i, Pap. iii (1871).

Alexander. There is among the Greeks
A lord of Trojan blood, nephew to Hector;
They call him Ajax.
Cressida. Good: and what of him?

SHAKESPEARE.—*Troilus and Cressida*.
En van peréu l'avertiguéron
Li parpaloum que la veguéron.

MIREIO.—*Mistral*.

Imago (15: 11). Head covered with straight, bristling hairs on the front, where they are as long as the width of the eye, thicker and longer than on the summit of the head; they are black, excepting in a pair of straight, longitudinal, lateral streaks,

which just include the antennae and just fail of reaching the outer edge of the head, diverging from each other as they pass backward; the band of either side broadens in passing posteriorly and originates at the very bottom of the front, where it is distinct, but along the front is bordered by a fringe of dark hairs which partially conceals it; behind the eye is a very slender border of white scales, and beneath all the hairs are of this color, with a slight yellowish tinge; palpi pure white throughout. Antennae uniform dull orange luteous, the under surface of the club, especially toward the tip, slightly infuscated, and the upper surface, especially next the sides and toward the tip, sometimes similarly affected. Tongue piceous throughout.

Thorax black above, covered with erect, delicate, moderately long, pale greenish hairs, which become less erect, more delicate and longer behind, the front half with a pair of pale greenish yellow stripes, the continuation of those on the head, broadening and becoming fainter as they pass backward, covering the patagia and terminating at their tip. Beneath, the thorax is black with a broad, longitudinal stripe of black hairs extending from behind the eyes next the extreme base of the wings to the side of the abdomen, the hairs faintly gray-tipped on the prothorax. Beneath this white with a greenish yellow tinge, but along the median ventral line, between the coxae, covered again and densely with black hairs. Legs very pale green, the femora covered exteriorly with white hairs, the base interiorly with black hairs; the tibiae faintly and the joints of the tarsi more conspicuously tipped with pale castaneous; spines black; claws reddish, spurs pale green, tipped with pale reddish; claws reddish, pale next the base, a little dark at the tip.

Wings above blackish brown with a slight purplish tone, marked with broad, transverse, dull whitish stripes with a faint, greenish yellow tinge. *Fore wings* with the costal margin moderately and almost uniformly arched but with the basal fifth and apical fourth a little more strongly than elsewhere; apex rather abruptly rounded giving a subfalcate appearance; outer margin gently and uniformly convex above the middle of the subcosto-median interspace, a very little more prominent in the ♂ than in the ♀; below this nearly or quite straight with a slight fulness next the tip of the lowest median nervule (♀), or very broadly and slightly convex (♂); lower outer angle squarely rounded; inner margin slightly excavated, but full next the tip of the internal nervure. The transverse stripes are as follows: next the base but not reaching it one slender and more or less curving, extending from the inner margin where it is broadest and about as broad as the eyes to the costal nervure, along whose inner edge it turns and follows with whitish flecks to about as great a distance from the base of the wing as half the width of the cell; its inner edge is well-defined throughout, its outer powdery; all the other stripes have somewhat powdery edges, but the outer of the bands crossing the cell less than the others; the second band likewise crosses the entire wing, excepting that it does not cover the costal edge and is generally fringed on the inner border with dark scales; it is broad, its interior border a little convex, opening outwardly, terminating below at the tip of the internal nervure, rarely just within it, above midway between the base of the costal border and the upper interior limit of the band above the interior base of the middle median interspace; the outer limit of the band is straight or nearly so and terminates below just within the middle of the inner border, above midway between the base of the costal margin and the middle of the black band which wholly or partially divides the pale bands surmounting the middle median interspace; the next band is but a narrow, straight, or slightly sinuous or curved stripe—sometimes but a powdery trace crossing the cell transversely and dividing equally the dark band which separates the pale band just described from the next beyond; this is a very broad band crossing the entire wing, like the first broad band described and with the same exception; it is divided above, in the cell, into two, by a black stripe which sometimes crosses the entire cell, equal in width to the two pale bands thus formed at its side, but generally narrows as it passes downward, and not infrequently passes but half or two-thirds way across the cell, its terminal portion heavily powdered with pale scales, both its interior and exterior border usually curved slightly, opening baseward; the interior border of this broad, pale band which crosses

the wing is a little irregular, showing a tendency to encroachments of the black along the nervures, but in general preserves a nearly straight course almost parallel to the outer limit of the inner, broad, pale band, though generally approaching it a little more closely next the inner than next the costal margin; the exterior limit of the band shows a similar tendency to encroachment on the part of the black, especially above the median nervure, but as a whole it is slightly curved, opening inward; its lower termination is as far from the tip of the submedian nervule as the width of the pale belt at this point; its upper crosses the base of the second superior subcostal nervule. Beyond this are two, short, narrow stripes: the first and longest is slender, passes from next the costal border to the upper median nervule, above is as broad as or slightly narrower than the upper limit of one of the forks of the broad, pale belt, narrows below nearly to a point, has its borders usually straight, and is sometimes broken into spots by the presence of flecks along the nervules it crosses; beyond this the principal superior subcostal interspace is crossed by a narrow, sublunulate, transverse spot, midway between the last mentioned stripe and the submarginal series of lunules to be described; this series is composed of spots which are more or less lunulate below, quadrate and transverse above, forming a continuous, nearly straight belt, subparallel to the outer border, broken only by the distinctly black nervules, and extends downward from the third superior subcostal nervule; its exterior border usually presents a uniform gentle curve opening outward as far as the middle median nervule, the exterior edge of each spot curving slightly and opening outward, from the upper median nervule downward; the whole is distant from the outer border by the width of an interspace in the middle of the band, more than that above, less below; the extreme width of the band is no greater than the upper portion of the stripe just outside the cell; below the upper median nervule it begins to narrow, and in the medio-submedian interspace seldom shows more than a very slender, broadly curved, powdery, lunulate streak. Occasionally the extra cellular markings of the under surface are faintly marked above. Fringe black, rather obscurely and irregularly white tipped. *Hind wings* with the costal border very strongly and rather regularly arched next the base, beyond gently and very regularly convex; outer margin, above the middle of the upper median interspace, uniformly deeply and abruptly crenate, the crenations forming nearly right angles, the general direction of the whole straight and lying at an angle of about 125° with the apical half of the costal margin; tail nearly as broad as an interspace, and so long that its tip is as far from its base as is the middle of the cell; rest of inner border gently crenulate at right angles to the upper portion; inner border with nearly the whole of its apical fourth greatly, abruptly and roundly excavated. Wing traversed by two oblique, pale stripes and one transverse pale stripe, which are all continuous with those of the front wings, when both are naturally expanded; the first is a narrow, uniform, white stripe, scarcely affected by greenish yellow, which, crossing the extreme base of the wing, runs midway between the inner border and the median nervure, at first distinct, beyond the middle of the wing powdery and gradually losing itself a little way beyond in the grayish flecking of this part of the wing; the next is a broad band with rather distinct edges, the inner border of which is straight or slightly curved, opening outward, extending from the costal margin just beyond the tip of the precostal vein, and directed, as far as half-way across the cell, straight toward the base of the lower median nervule; then curving slightly outward it continues parallel to this nervure, and just outside of it to the middle of the basal two-thirds of the interspace, where it curves around to meet the opposite border and partially loses itself in the powdering beyond; the exterior border of the band, starting from the costal border, runs nearly parallel to the interior border but gradually approaches it in the least degree, crossing the subcostal nervure at its first divarication; the outer band is more nearly transverse and crosses the wing midway in position and direction between the previous band and the outer border; next the costal margin it is of equal breadth with the former but it narrows more rapidly, with nearly straight borders and terminates at the middle of the medio-submedian interspace, or occasionally at the lower subcostal nervule, with a rounded extremity similar to that of the previous band. The central parts of the wing are rather heavily pow-

dered with pale bluish scales, giving a grayish blue effect. In a limited field, the exterior border of which follows a bent curve, running from the exterior edge of the outer pale band to the middle of the lower median nervule and thence at right angles toward the inner border, to meet which more directly it curves when it has reached the middle of the submedio-internal interspace; the interior limit of the powdery space is nearly marked by the extremity of the cell, though it extends along the edges of the pale bands nearly or quite to their middle. Separated but slightly from this powdery space in the medio-submedian interspace, and from the excavation of the inner border by its own width is a bright carmine broad lunule, generally extending the whole width of the interspace, broader next the inner border than upon the opposite side, occasionally margined above very slightly with a whitish flecking, and sometimes accompanied by a few clustered carmine scales in the lower median interspace, which occasionally become enlarged into a spot, which at its greatest becomes half as large as the primary spot, with its interior edge on a line with the exterior edge of the major spot. There is a submarginal series of large and distinct whitish lunules in all the interspaces above the tail, on the side next the costal margin broadest, and having their middle on a line with the previous part of the outer margin, the upper one slender and powdery, the lower subtriangular. In corresponding places in the two lower median interspaces, but a little further from the margin, lunulate powdery spots of rather pale blue, the inner the larger and surmounted by a second powdery lunule of greenish yellow scales, which is but the prolongation of a pale yellow spot which edges rather broadly the excavation of the inner border; the tail is broadly bordered with hoary white scales, so broadly as to unite and cover the whole of the terminal portion (sometimes the terminal fourth) and which gradually narrows until it unites as a mere line with the yellowish edging of the crenations of the inner border; yet the whole tail has a black fringe, excepting the extreme tip; the hollows of the crenations of the outer border are narrowly edged with pale yellow, a color common to the fringe at these points, though at the nervure tips it is broadly interrupted with black.

Beneath: *fore wings* with the ground color dull brown, the markings of the upper surface repeated, with the following exceptions and additions: the slender basal pale stripe reaches to the extreme base of the wing, and crosses the costal nervure to the margin, like the other bands; the other bands are more clearly defined, even the dark patch dividing the central pale band scarcely showing any signs of a powdery edge; separated from and nearly parallel to the interior edge of the submarginal stripe, and just touching the tips of the two previous shorter stripes is a slender, somewhat irregular and unequal pale striga, extending from the costal margin to the lowest median nervule, presenting the appearance of a rubbed line, as if the scales had been removed. *Hind wings* with the ground color scarcely so dark as above, especially in the upper half of the wing, with markings similar to those of the upper surface but with some conspicuous additions: the narrow basal pale stripe is distinct and equal and reaches nearly to the carmine spot; the middle pale band is similar to that of the under surface, but is less obscured by the powdering near the tip; the same is true of the outer band, which rarely fails also of reaching the median nervules; the black band formed between these two, however, is enlivened by a series of narrow, equal, transverse, gently curved, subcontinuous, carmine stripes, crossing the middle of the band in the upper half of the wing, extending from the costal edge to the next to the lower median nervule, and excepting the uppermost, bordered interiorly by a similar pure white stripe, which is as broad as the carmine in all but the median interspaces; the spots above the lower subcostal nervure usually form one continuous series, and those below another, but the latter are often disconnected; between the subcostal and median nervures, the white stripe borders the outer limit of the cell and is thus wholly in the outer half of the dark band, and the interior limit of the carmine patch of the middle median interspace is on a line usually with the exterior edge of the similar spot in the interspace above; the carmine spots of the upper surface are repeated, that of the lowest median interspace as distinct and nearly as large as the other, forming an inverted lunule, and both are broadly edged interiorly with pure

white, the inner the less distinctly. The submarginal lunules of the upper surface, both yellow and blue, are repeated beneath but more conspicuously, the yellow lunules usually extending to the border, and followed above in each interspace by a similar transverse bar, which unites itself more or less distinctly to the lunule of the interspace above, with which it is nearly or quite aligned; in the upper median interspace, however, it is formed of powdery yellow scales; the blue lunules, though powdery, are much more distinct than above, and are usually edged above with hoary; and these too, are surmounted at a short distance by strongly bowed, powdery lunules of pale yellowish green, that of the lower median interspace corresponding to that above, and like it united to a yellow spot at the angle of the excavated inner border. Midway between the inner carmine spot and the extremity of its interspace is a delicate transverse bar of blue scales; the powdering of the median area is more diffused and scattered than above, and the hoary bordering of the tails seldom extends more than half way toward their base; the costal edge is clay yellow at the summit of the outer pale band; the markings of the outer edge and the fringe are as above.

Abdomen black, the sides with a broad, superior, longitudinal, whitish stripe and a narrower inferior one, united to the upper on the last segment, but immediately previous to that broadened and divided longitudinally in halves, by a slender black line, which crosses four or five segments; the black band between the upper and lower pale lateral bands is continuous with the black thoracic band which hugs the base of the wings beneath. Claspers of male (35:26-29) yellowish white, edged with black, the denticulate ridge parallel to outer margin slight, the denticles fine and small, above connected with a horizontal, thin, high and straight lamina, running toward the upper base, itself denticulate on the inner edge; from near the connection of the two, and supported by the latter, springs a slightly down-curved, long and tapering spine, directed toward its fellow on the opposite valve; while at the lower extremity of the areolate denticulate ridge arises a thin and slight, triangular, pointed lamina.

IPHICLIDES AJAX MA

Measurements in millimetres	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	34.25	36.25	38.25		39.	
antennae.....	13.	13.	13.6		12.75	
hind tibiae and tarsi..	9.5	10.	10.25		10.	
fore tibiae and tarsi..	8.	8.	8.2		8.6	

Length of tails, ♂ 14.4-16.8 mm.; average, 14.4 mm.

IPHICLIDES AJAX TELAMONIDES.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	37.	38.	39.		39.	
antennae.....	12.1	12.5	13.		12.75	
hind tibiae and tarsi..	9.5	10.	10.		9.6	
fore tibiae and tarsi..	8.	8.5	8.8		8.25	

Length of tails, ♂ 18.5-20; average, 19 mm.; ♀, 16.25 mm.

IPHICLIDES AJAX AJAX.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 16.5 mm.						
Length of fore wings.....	45.	45.5	47.	40.5	43.	45.5
antennae.....	13.5	13.25	13.5	12.5	13.2	14.6
hind tibiae and tarsi..	11.	10.5	10.5	10.5	10.6	
fore tibiae and tarsi.....	8.75	9.	9.	8.25	8.75	9.75

Length of tails, ♂ 26-28.25 mm.; average, 27.75 mm. ♀, 23-28 mm.; average, 26 mm.

Described from 32 ♂, 6 ♀, of which more than half were I. a. ajax.

Dimorphic forms. The above description is drawn up entirely from *I. a. ajax*. *I. a. MARCELLUS* differs from it in the following points: the bristling hairs on the front of the head and the softer hairs of the thorax are noticeably longer and more profuse. Fore wings with the costal border more gently convex, excepting toward the apex, which is more abruptly curved downward; outer margin of ♂ with two exceedingly slight, convex curves divided by the middle of the upper median interspace; of the ♀ the same, but even less conspicuously so. Tail of hind wings no broader than half an interspace, and if doubled back, the tip not reaching the tip of the cell. As to the markings of the upper surface, the paler bands are noticeably broader, the black stripes crossing the cell of the fore wing occasionally stopping at the subcostal nervure instead of extending to the margin, and the black stripe dividing the upper part of the outer broad band sometimes reduced to a mere patch. Some sign may usually be seen of the extra white stripe of the upper surface; on the hind wings the two carmine spots are almost invariably of equal size, always connected and but little or not at all constricted at the point of union, forming a sinuous bar; occasionally traces of the other carmine spots of the lower surface may be seen above ("subvar. *abbottii*" of Edwards), but the white stripe next the inner border, on the other hand, has become but a powdery streak. Beneath, the markings scarcely differ from their appearance in *I. a. telamonides*, unless it be in the slightly greater extent of the pale markings, and especially of the broad areas.

I. a. TELAMONIDES differs from the typical *I. a. ajax* in the following particulars: the projecting hairs on the front of the head as also those on the thorax are slightly longer. Fore wings with the costal border less regularly arched, being rather less full in the middle and more curved in the apical third; the outer margin of the ♂ is almost straight above the middle median nervure, below which it falls off a little; in the ♀ there is a slight fulness to the lower half, but otherwise it does not differ from the ♂. In the hind wings it differs only in the tail, which is scarcely more than half as broad as an interspace and if doubled upon itself the tip would not reach the second divarication of the median nervure. As to the coloration of the wings, the general effect of the upper surface is lighter, from a slightly increased breadth to all the pale markings, while at the same time their borders, especially above the median nervure, are better defined in both wings. Upon the hind wings, the second carmine spot in the lowest median interspace is never absent and is usually almost as large as the outer one. In the form of a round spot or a reversed lunule, ordinarily combined with the outer spot to form a sinuous band constricted in the middle. The hoary scales which border the tail seldom extend more than half way toward the base, except as the innerest line, but they usually reach that point. Beneath, the differences are exactly similar to those of the upper surface; in particular the pale stripe within the outer greenish white band is distinctly broader than in *I. a. ajax*, and, it should be remarked, not infrequently makes its presence known upon the upper surface, the submarginal lunules with their accompanying white bars are more conspicuous, less frequently curved and in poorer alignment than in *I. a. ajax*.

Malformations. Edwards states (*Psyche*, iii: 114) that he has reared a specimen of *I. a. ajax* which came from the chrysalis "perfect, except that there was no trace of one hind wing." And Riley records in his notes that he once obtained a chrysalis with the larval head still attached.

Egg (66: 5). Surface broken up into minute, rounded, pentagonal cells of not very unequal diameter, averaging about .025 mm. over the whole egg, faintly marked. The shell appears to be very thin, to be wanting in any glutinous secretion and smooth. According to Dr. Riley it is "pea-green when first laid, gradually approaching to black." Height, .85 mm.; breadth, 1.05 mm.

Described mostly from specimens in alcohol sent by C. V. Riley.

Caterpillar. *First stage* (73: 12). Head brownish piceous, the mouth parts pale at base, beyond of the color of the head. Body dull plumbeous, mottled irregularly and faintly on the sides with livid tints in short longitudinal streaks. Legs dusky above; prolegs concolorous with body or a little paler. Warts dusky with pale brown hairs. Spiracles dusky in a pale field. Lips of osmaterial cleft dusky. Length, 3.5 mm.

Second stage. Head (80:13) piceous above, becoming fuliginous before the middle and below with a yellowish tinge, covered with very short hairs. Mouth parts dull amber colored or pale in part; ocelli black in an amber field; antennae livid, mixed with blackish. Body covered with narrow, equal, transverse stripes of black and white, uniting in a common, dark, fuliginous field about the stigmata, below which is a broken, longitudinal, narrow, white stripe; a single white stripe on the anterior part of the segments is frequently supplanted by a lemon yellow one, especially on the first thoracic and first abdominal segments where the change is complete. In another it is most noticeable in the laterodorsal field. Lips of osmaterial cleft black. Body covered uniformly with very short, black, infrequent hairs. Legs dusky; prolegs dusky on basal half, yellowish on apical. Length, 8.5 mm.

Third stage. Head (80:14) smoky brown above, much paler becoming luteous below. Anterior ocelli set in a blackish fuscous band; basal joint of antennae white, rest of the antennae and other mouth parts pale luteous. The general hue of the body is, according to Riley, often smoky purple, the lines much more margined with black than in previous stages, and the thoracic segments are also blacker. In a blown specimen before me the thoracic segments are so much darker as to be almost wholly blackish fuscous with narrow, transverse, tremulous lines of dirty yellow. The incisures between the third thoracic and first abdominal segments is velvety black, as in subsequent stages, bordered in front by a pearly white band of equal width which along the stigmatal line encloses a slender streak of blackish fuscous, and is bordered behind by an equally broad stripe of lemon yellow terminating at the spiracles. The abdominal segments are pale testaceous at the incisures, the body of each segment being blackish fuscous, more or less fuliginous, with three equal and equidistant, narrow, tremulous stripes of pale yellow, the anterior one rather more strongly tinged with yellow than the others, especially below where it passes just in front of the stigmata; these stripes terminate just below the stigmata, and to a greater or less degree are united at the base by a short, transverse, infrastigmatal, white stripe, parallel to which is a ventrostigmatal white stripe broken at the incisures and faintly margined with fuliginous. Length, 19 mm.; breadth of head, 2 mm.; breadth of third abdominal segment, 3.75 mm. Described from a blown specimen.

Fourth stage. Head (80:15) much as in preceding stage but distinctly pale luteous behind the summit of each hemisphere and on the lower third of each of the cheeks, including the entire ocellar field with the black bases to the ocelli. Body much as in third stage but the ground color of the thoracic segments is a warm, rather pale purplish brown enlivened by many transverse lines of greater or less length of black green, and all the transverse, bright stripes margined distinctly with velvety black or blackish brown. The incisures of the abdominal segments are broadly pallid and the transverse markings much more diversified than before, the ground being paler than on the thoracic segments, but encroached upon to such a degree by the transverse bandings as to be very inconspicuous. Next the pallid incisures, however, especially in front, the segment is always more or less fuliginous, and there follow four black- or brown-edged bright bands, the second one brightest and lemon yellow, the others less brilliant, the ground appearing merely as slender lines frequently, perhaps generally, broken between the dark edging of the adjacent stripes. The infrastigmatal and ventrostigmatal pale stripes as in the preceding stage, but more distinctly margined with black or brownish. Length, 30 mm.; breadth of head, 2.5 mm.; breadth of third abdominal segment, 7.5 mm. Described from blown specimens.

Last stage (76:14). Head (80:16) green, paler beneath than above, the paler, lower portion sometimes ascending in a triangular way upon the front as high as the top of the frontal triangle but including more than it, while the restricted frontal triangle is nearly as dark, at least on its upper half, as the upper portion of the head. Ocelli black. At the earlier part of this stage the appearance of the caterpillar is much the same as in the fourth stage, only the velvety black band at the incisures between the last thoracic and the first abdominal segments is much brighter and so more conspicuous, and is edged anteriorly with a narrow stripe differing from the ground

color much less than in the preceding stage and so inconspicuous; occasionally this velvety black stripe is broken briefly at the dorsal line. Later and when full grown, the caterpillar is pea-green with much less distinct, transverse markings, sometimes indeed with this exception they are almost entirely obliterated, but generally the darker markings are made plain by transverse series of dots or brief, transverse lines of black or brown, sometimes reduced so as not to be noticeable without a lens, and generally slightly more distinct upon the sides than above. When most highly marked there are three distinct, transverse stripes narrowly margined with black, the anterior slightly broader than the others and yellow, the others pale greenish blue. Just behind the osmateral cleft on the first thoracic segment is a very bright, lemon yellow, transverse line edged as broadly both in front and behind with piceous. Legs bluish. Prolegs color of the under surface of the body. Spiracles livid in a black setting. Length, 55 mm.; breadth of head, 3.6 mm.; breadth of third abdominal segment, 12 mm. Described from blown specimens with the aid of notes of C. V. Riley.

Chrysalis (85: 11-12). Ocellar prominences when viewed from above having a direction divergent from each other at right angles, widely separated by a broad and shallow curve, almost or quite flat over nearly half its course; basal wing tubercle not strongly pronounced, far less so than the ocellar prominences. Surface of body, especially upon the dorsal portions of the abdominal segments, with a large number of bead-like, hemispherical warts and occasionally short, transverse, raised dashes; in addition to which the same portion of the body is sharply and irregularly punctate, the punctae being of unequal size and irregularly distributed, but very numerous and sharp. Prothoracic spiracle not more than one-half as long again as high. Color either dead leaf brown or bright green, according to Edwards. Judging from dried specimens there is a tendency to the development of three rows of infuscated blotches upon the abdomen, one of which margins, on the interior side, the laterodorsal carinae and consists of two sometimes confluent, roundish spots, the larger anterior, the smaller posterior; the second series, rather broad oblique bars, follows the posterior upper edge of the oblique carina which lie midway between the former series and the spiracles; the third series is formed of round, suprastigmatal, anterior spots. Length, 20-24 mm.; height, 7.5-8.25 mm.; height of mesonotal tubercle above back, 1.35-1.5 mm.; distance apart of tips of ocellar tubercles, 4.6-5 mm.; width of head, 3.9-4.6 mm.; of body at basal wing tubercles, 6.1-7.5 mm.; at tip of third abdominal segment, 7.5-8.75 mm.

This chrysalis differs from that of *I. podalirius* of Europe in the greater separation of the ocellar tubercles, the cleaner cut, sharper surface sculpture of the whole body and the more open and broader prothoracic spiracle.

Distribution (26: 7). This butterfly occurs east of the great plains, in the Carolinian and the southern half of the Alleghanian fauna; it extends north almost to the annual isotherm of 50°, even passing that line in the region of the great lakes, so as to include southern Michigan and the whole of Ohio, but, apparently, not following the upward curve of the isotherm beyond the Mississippi. In the south it reaches the Gulf coast and passes down the peninsula of Florida, at least as far as the latitude of Lake Okechobee (Palmer, Wittfeld, Schwarz). Westward it is found as far as Racine, Wis. "common" (Hoy), central Iowa (Osborn, Parker), Missouri, "common" (Riley), eastern Kansas, "abundant" (Snow), and Texas (Edwards), its extension in this direction being limited apparently by the prairie region. It occurs on the banks of the Mississippi as far north as Davenport, Io. (Putnam) and Rock Island, Ill. (Parker). It is found also in other parts of northern Illinois at Pontiac

(Mundt) and elsewhere (Worthington), appeared in 1886 in numbers in the streets of Chicago (Hancock), occurs in many localities in Ohio, such as Cleveland, "not uncommon" (Kirtland), "common where papaw bushes are" (Kirkpatrick), Columbus, "still more abundant" than at Cleveland (Kirtland), where it is rather common" (Ison), Rockport, Poland and Hudson (Kirtland) and eastern Ohio (Foster); and has even been found in southern Michigan (Mus. Mich. Univ., Andrews) and western New York (Bruce); and in a few instances in Ontario, such as Komoka and Point Pelee (Saunders), North Ridge (Lowe) and Ridgeway (Moffatt). In Maryland (Uhler) it is "rare" and about Philadelphia (Blake) it is not common.

Finally specimens have been taken on Staten Island (Davis) and the western end of Long Island (Graef, Hulst) which is its nearest approach to New England.

Its occasional appearance in the north in places which it does not appear regularly to inhabit, and in some instances, as we shall see, far from its common food plant, would seem to indicate that it occasionally attempts to extend its domain by migration in larger or smaller numbers. One instance of such a migration has been observed, and the relation of Mr. Hancock is so explicit that it may be given in his own words:—

During the fore part of June, 1886, unusual numbers of the ajax butterfly migrated through this city. Since the only feeding places accessible to them in Chicago at this point are scattered lots where a few bunches of clover or dandelion make up the principal flowering plants, the butterflies made few if any stops at these, but flew along the streets near the ground at a rapid rate northward, and it was with considerable difficulty that a single specimen was secured. On June 12th a visit was made at Wood Lawn, Ill., a few miles south of Chicago, where the butterflies were found quite as plentiful, and showed the same uneasiness in their flight. In a cleared grassy spot in the woods near at hand, white clover had spread its blossoms in broad patches, where occasionally a butterfly would make a hasty stop, which, however, was only for a moment, when its form would again be seen disappearing through the woods. (Amer. nat., xx:976.)

Abundance and oviposition. The extreme abundance of this species is well attested by Edwards, when he says: "at certain seasons it is almost impossible to find a young plant [of papaw] that is free from . . . eggs, and it is easy to collect scores of them."

"The female of ajax may frequently be seen coursing through the papaw trees which . . . cover the lower hillsides, or hovering about the young plants that spring up in the cultivated fields, searching for leaves on which to deposit her eggs. After touching or running over and rejecting several, she finds one suitable to her purpose. Thereupon, balancing by the rapid fluttering of her wings, she stands for an instant with legs stretched at full length, perpendicular to the body, and curving down the abdomen until it touches the surface, deposits a single egg; then flies away, presently to alight on a second leaf with like intent. Sometimes the egg is upon the stem and occasionally on the under side of the leaf, but almost always it is on the upper side, and but one egg will usually be found on the same leaf. The process of laying continues for several successive days." (Edwards.)

Food plants. The caterpillar, according to numerous authorities, feeds upon the papaw, *Asimina triloba* Dunal, and, according to Dr. Chapman, upon all our other species of the same genus, *A. parviflora* Dunal, *A. grandiflora* Dunal and *A. pygmaea* Dunal. Boisduval and Le Conte also state that it feeds upon the latter and upon *Anona palustris* (whatever that may be)—plants belonging to the Anonaceae or custard-apple family. No one appears to have found it on any other plant excepting Aaron, who states that it is found also on "spice wood," by which he doubtless means Benzoin odoriferum, and on "upland huckleberry," some one of the Vaccinieae, plants belonging respectively to the Lauraceae and Ericaceae, and far removed, structurally, from the Anonaceae. But several persons have observed that papaws were not to be found in some northern localities where the butterfly had been found, such as Ames, Ia. and Racine, Wis.

Habits of the caterpillar. The young caterpillar as soon as hatched devours its egg-shell, but usually leaves the part glued to the leaf. The caterpillars live, according to Wittfeld, on the under side of leaves, and, more than other species of his acquaintance, shows cannibalistic propensities. Some of the caterpillars, as shown by Mr. Edwards's observations, attain their full growth in twelve days, although others, especially the produce of the earliest butterflies, require nearly a month. They do not draw the leaves of the plant together like some other larvae of Papilioninae, but are to be found in every stage "resting on the surfaces of the leaves, and one would suppose they must be nearly exterminated by birds. But like all Papilio larvae they emit from the head [first thoracic segment], at the same time that they project a Y-shaped tentacle, a peculiarly acrid and sickening odor, which must effectually protect them" (Edwards). In a letter, Mr. Edwards adds that he does "not believe a starving bird would touch one, the stench being so strong as nearly to turn one's stomach," yet I could not induce one in the second stage to eject its osmateria.

Polymorphism and life history. Science is deeply indebted to Mr. W. H. Edwards, for the thorough manner in which he has worked out the history of this butterfly by careful studies in the field and innumerable experiments. This author has not only indisputably established the identity of two forms previously described as distinct species (though often presumed to be identical), but has proved the existence of a third permanent form and has admirably traced the relations of each form to the others. The account given below is almost entirely based on his observations.

No histories of butterflies are of deeper interest than those of polymorphic species, whether considered in themselves alone or in the light they are destined to throw upon the origin of species and races, problems which demand the profoundest thought and most conscientious investigation; and since this species is polymorphic in a larger sense than almost any other American butterfly is known to be, our interest is greatly enhanced.

As stated, ajax appears under three different forms—marcellus, telamonides and ajax, the polymorphism affecting both sexes equally. Yet "Whosoever you take him to be, he is Ajax."

These forms are shown by Mr. Edwards to produce one another in a complicated manner, but in general the imago exhibits what has been termed seasonal polymorphism; that is, a series of individuals adhering, in all their variations, to several distinct types, each type appearing at a different season of the year from the others; thus marcellus is the early spring type, telamonides the late spring, and ajax the summer and autumn type. Nearly all the butterflies which, in West Virginia, emerge from the chrysalis before the middle of April are marcellus; between that and the end of May, telamonides; after this, ajax. The first two, however, do not appear properly to represent distinct broods, which is one of the most extraordinary features in the history of the insect; for telamonides, judging from recorded observations, is not the direct conseasonal produce of marcellus, but both are solely made up of butterflies which have wintered as chrysalids, those which disclose their inmates earliest producing marcellus, the others, telamonides; while all butterflies produced from eggs of the same season—and there are several successive broods—belong to ajax. Thus, besides the true seasonal dimorphism which distinguishes the butterflies produced from eggs of the same season from those derived from eggs of the previous season, we have a secondary seasonal dimorphism, as it may well be called, separating the earlier from the later produce of wintering chrysalids.

Mr. Edwards has also proved by his experiments that a portion of every brood of chrysalids, instead of disclosing the imago at the end of the ordinary time, retain it, occasionally until the appearance of a subsequent brood, but usually until the next spring. The spring brood (marcellus-telamonides) is therefore by no means wholly produced from chrysalids of the final brood of ajax, but in large measure from those of all the earlier broods, even including the earliest marcellus; the proportion of chrysalids which continue until spring increases, as a rule, as the season advances, Mr. Edwards's statements showing that of those produced from eggs laid in April, more than ten per cent. pass over, those from eggs laid May 1-25 about thirty-five per cent., from that time until the end of June from fifty to sixty per cent. and from those laid in July about seventy per cent. Marcellus and telamonides, then, produce ajax the same season, or either marcellus or telamonides in the spring; ajax produces itself the same season, or one of the others in the spring; but neither marcellus nor telamonides is produced the same season by any of the varieties.*

*The recorded exceptions to this rule (which serve only to strengthen it) are the following: a telamonides was captured September 12th, and an ajax April 11th; Abbot, too, states in his MS. that he bred a butterfly of ajax ("autumnal ajax" he called it, showing

We will now consider the life-history of the species. The insect is multibrooded and winters as a chrysalis. The earliest variety, *marcellus*, "appears in Kanawha valley (W. Va.), from the 15th to 20th of March, by which time the peach trees are usually in blossom. On these the females may certainly be found, and a little later, on the apple and in great numbers on the wild plum. The males appear a few days earlier [than the females] and are to be seen by the water-side or upon the road, but rarely upon flowers. The larvae feed on the papaw, and as this is one of the latest of our trees to put forth its leaves, the butterflies are out at least from two to three weeks before the young shoots of the food plant are visible. But no sooner do these appear than the females hasten to deposit their eggs." This is early in April and they continue to lay them until as late as May 23d; the eggs hatch in from seven to eight days and the caterpillars are from twenty-two to twenty-nine days in attaining their growth.

Marcellus Telamonides, which, as stated above, is only a later variety of the same brood, "begins to fly some weeks after [*marcellus*], and both forms . . . are for a time common." Telamonides evidently lays its eggs very soon, for, "on dissecting the abdomen of a newly emerged female, the eggs are found to be fully formed though not full-sized. I conclude that they mature with great rapidity because fertile eggs are laid by apparently fresh and uninjured females," and he records in another place pairing taking place with females whose wings were yet moist and limp from fresh eclosion. Mr. Edwards records eggs laid from May 11th to June 2d; these are hatched much more rapidly than those of *marcellus*, namely in from four to five days; the caterpillars, too, mature more quickly, attaining their growth in from fifteen to eighteen days, thus often overtaking their tardier predecessors. "About the first of June [*marcellus* imago] disappears, and before the end of the month telamonides also."

Still farther south, it is evident that the apparition of the butterflies is advanced; for in Georgia, Abbot records *marcellus* as emerging from the chrysalis March 2d, and Dr. Chapman took it in northern Florida, in the latter half of February, 1868 and 1869; late in March he also records the

his knowledge of the identity of the early and late forms) on August 2 from a chrysalis of September 9 of the previous year! The other exceptions occurred in the course of Mr. Edwards's experiments. This indefatigable worker has traced the history of more than two hundred individuals from egg to butterfly, and of these only two did not follow the usual course; these two belonged to a brood produced from eggs laid by *marcellus* before the middle of April; sixty individuals completed their transformations the same year; all (excepting a pair of belated *ajax*) hatched between

June 1st and 8th; fifty-eight chrysalids produced *ajax*, one *marcellus* and one telamonides; so that the solitary specimen of *marcellus* was far out of season, for Mr. Edwards expressly says "about the first of June [*marcellus*] disappears" while the one specimen of telamonides was certainly much later than usual; and in any case, *marcellus* should produce neither *marcellus* nor telamonides the same season. It must be remembered that similar instances of untimely eclosion are by no means very uncommon among butterflies. Some are recorded in this work.

I do not recognize any new observations or any new history in the history given of the broods.

species as "numerous," so we may perhaps fairly surmise that telamonides appears at this time.

Marcellus

"About the first of June [ajax] begins to appear and shortly is out in great numbers, continuing to be abundant till last of October." The broods overlap each other so as to be distinguished with difficulty, but it appears that, besides the brood of marcellus-telamonides already mentioned, there are at least three successive broods of ajax.* The larvae of telamonides, as we have seen, often overtake the later larvae of marcellus, the earlier larvae are by this time (the middle of May) in chrysalis and continue fourteen days; the first brood of ajax from these chrysalids, and from those of telamonides, continues to emerge until at least the ninth of July, or for more than five weeks.† The chrysalids from larvae of telamonides hang from eleven to fourteen days, and the time for the completion of their entire cycle is only from thirty to thirty-seven days, which is seldom exceeded by ajax (twenty-seven to thirty-eight days), although much quicker than the period of marcellus (forty-three to fifty-one days).

The female of the first brood of ajax begins to lay eggs—which, like those of telamonides, hatch in four or five days, in Florida in three days according to Wittfeld—at the very beginning of June, and butterflies produced from them, i. e. the second brood of ajax, are upon the wing early in July—not only before the butterflies of the previous brood have disappeared, but even before all the chrysalids from eggs of telamonides have eclosed their butterflies. The attempt to trace the sequence of the broods is, therefore, almost hopelessly bewildering; but it seems probable that the second brood of ajax (the third of the species) appears in abundance early in July; it is, perhaps, in speaking of the first brood of ajax in Alabama, that Gosse says they are "nearly all gone July 1st." These larvae attain their growth in from twelve to nineteen days, and hang as chrysalids from ten to fourteen, and it is therefore impossible that there should not be a third brood of ajax; that a fourth brood is even at times possible would appear from the fact that the insects continue to change from one stage to another without any apparent regard to the approach of winter, which overtakes many in conditions under which they are obliged to succumb; thus Mr. Edwards writes from West Virginia: "At the time of frost there are eggs and larvae in every stage, which are all killed"; and Mr. Riley from Missouri: "I have found eggs and larvae two-thirds grown, as late as the

* Mr. Edwards's language on this point seems a little vague; he says: "Besides the first brood from [marcellus] or telamonides, there are three successive broods of [ajax], and the larvae of the fourth give chrysalids that go over the winter, thus making five broods per year."

† Speaking of a brood of larvae from eggs of marcellus reared in 1871, Mr. Edwards says that while the mass of the chrysalids (all of

which suspended within a week of each other) gave the butterflies between June 1st and 6th, yet "on 23d June, full three weeks after its period, came another ♀ [ajax] and a second followed on the 12th of July"; but even the latter date is only three days after that of others of this brood (from eggs of telamonides however), which were but thirty-seven days from egg to butterfly.

middle of October, when the leaves were almost all fallen; the parent ought to know better if instinct is so infallible." Doubleday remarks that on the Ohio the species was very numerous after the tenth of September; if this is an indication of a new brood in September, and if the second brood of ajax appears early in July in this locality also, then the butterflies seen by Doubleday must have been a fourth brood of ajax or the fifth of the species. There is, therefore, a continual flight of this species from early spring to time of frosts; and yet in Mr. Edwards's opinion an individual life hardly exceeds two or three weeks.

The results reached by Mr. Edwards in his study of this butterfly have been the subject of some curious comments by Mr. Raphael Meldola of England, in an interesting paper upon the "amount of substance waste undergone by insects in the pupal state." (Ann. mag. nat. hist., (4) xii: 301.) This writer thinks he has shown that the comparative size of the three forms of ajax is exactly opposite to what we should expect. In his preliminary general remarks, it is presumed *a priori* that as there is in all insects gain of matter in the larval state, and loss during the pupal, the size of an individual imago of any given species "would be, *ceteris paribus*, inversely proportional to the ratio of the pupal to the larval period, or directly proportional to the ratio of the larval to the pupal period."

He attempts to test this theory by tabulating the statements of Mr. Edwards concerning the duration of the stages in the different forms of ajax, and he finds that there is "a relationship, but exactly the reverse of that which would be anticipated from the conclusions previously set forth."

Marcellus, telamonides and ajax, as we have seen, succeed each other in season; they also increase regularly in size in the same order. The following table represents the duration of the several stages and is taken by Mr. Meldola from Mr. Edwards's work.

Name of variety.	Egg.	Larva.	Chrysalis.	Total.
Marcellus	7-8 days	22-29 days	14 days	43-51 days
Telamonides	4-5 "	15-18 "	11-14 "	30-37 "
Ajax	4-5 "	12-19 "	11-14 "	27-38 "

The next table is Mr. Meldola's attempted tabulation of the facts, by which he comes to the conclusion stated.

Name of variety..	Ratio of mean pupal to mean larval period.	Ratio of mean larval to mean pupal period.	Mean expanse ♂.
Marcellus	$\frac{27.5}{15.5} = 0.549$	$\frac{27.5}{15.5} = 1.821$	2.70
Telamonides	$\frac{15.5}{19.5} = 0.757$	$\frac{19.5}{15.5} = 1.320$	3.00
Ajax	$\frac{15.5}{19.5} = 0.806$	$\frac{19.5}{15.5} = 1.240$	3.35

"It is here seen," says Mr. Meldola, "that the size of the variety is directly instead of inversely proportional to the ratio of the pupal to the

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larval period, and *vice versa*." Unfortunately for this conclusion the figures given by Mr. Edwards, or their reduction by Mr. Meldola, refer in each case to the *progeny* of Marcellus, telamonides and ajax, and do not bear upon the question at all. In every instance given in the tables, the progeny or resultant is ajax. By Mr. Meldola's rule, marcellus and telamonides, being the produce of wintering chrysalids, should be, as they are, smaller than ajax, since the latter is always the result of short-lived, summering chrysalids; unless, however, some unknown factor plays a part, telamonides should be smaller than Marcellus, because produced later in the season from wintering chrysalids; but here the opposite is the case.

This was pointed out by me, much as above, shortly after the publication of Meldola's paper, and my remarks (originally made before the Natural history society of Boston) were reprinted in the same journal not long after. In a subsequent note in the same place (xiv: 239-40) Mr. Meldola thanks me "for pointing out the true signification of Mr. Edwards's tabulated results—a signification which it is difficult to gather from the text"—but adds: "With regard to the issue of Mr. Scudder's remarks, however, I may state that these do not in any way affect the main conclusion arrived at by me in the paper referred to. *The polymorphic forms of I. ajax do not conform to the law of substance waste.*" (The italics are his.) It appears to me, on the contrary, that in general they do, and it is not impossible that when we know the birth-time of a large number of chrysalids of marcellus and telamonides, we shall discover that the infraction of the law is more apparent than real.

Habits and flight. Doubleday, speaking in particular of the spring-brood writes (Arc. entom., i: 61). "I rarely saw it alight on flowers, never, that I recollect, on the ground. Now and then it would alight on flowers of [*Asimina*] *grandiflora*. . . Its flight low, rapid (not sailing with its wings expanded as *thoas* and others). It flies in and around the low scattered brushwood, by the sides of clearings, old deserted cotton fields, and similar situations, often returning to the same spots; in fact so regular did the round seem to be taken, that I have often waited behind a bush for a few minutes for the return of an individual I had seen pass, and rarely failed by this means to capture it. It is a shy insect and darts out of its course at the least motion." Speaking of the autumn brood, which he considers a distinct species, he adds (*loc. cit.*): "its flight is rather more graceful than that of [the spring brood]; it sometimes alights in the muddy places by the roadsides where little streamlets cross, especially during the heat of the day." Kirtland, too, remarks: "these two species are readily recognized by their peculiar mode of flight"; but Edwards makes no comment upon this point. Abbot says it "flies very swift."

Enemies. "Many eggs," says Edwards, "are destroyed by insects and spiders. There is a minute scarlet spider scarcely larger than the egg it-

self, that mounts upon it and from a puncture extracts the contents. I frequently met the shells so despoiled before I discovered the cause, and have since observed the marauder in its operations. I have also lost in a single night, owing as I supposed to crickets, numbers of eggs laid in confinement." Speaking of the caterpillar he says: "I have . . . seen spiders feeding upon them, attacking even the head, and they have other enemies among the insects. They are very little troubled by ichneumon flies in this valley, and I have rarely lost a chrysalis from that cause. Consequently no [swallow-tail] is so abundant here throughout the season. I find on breeding them that a considerable percentage of the eggs do not hatch, and that more or less of the larvae die at every moult, as well as in the effort to change the chrysalids. Multitudes of chrysalids must be destroyed in the winter by birds and mice, as they are but imperfectly concealed under stones and roots, or even among the stems of the grasses, so that of the tens of thousands of eggs that are annually deposited, but a very small proportion produce butterflies." The caterpillar is, however, sometimes attacked by *Trogus exesorius* Brullé (88:3) the imago of which escapes from the chrysalis by cutting a circular opening, usually through one of the wings; also by *Exochilum mundum*, according to Mundt; and by *Pimpla annulipes*, as discovered by J. B. Smith, all three hymenoptera of pretty large size. No dipterous parasites are known.

Desiderata. Although so carefully studied by Mr. Edwards, there are still some points in the history of ajax which require investigation. The distribution of the insect in the west and north should be more definitely determined. The season of the apparition of the different varieties in the extreme southern states, and of the different broods of ajax everywhere, is still unknown and will require careful study; but perhaps the most interesting and fruitful investigation will be to follow still further the line of Mr. Edwards's experiments, and study the proportion of chrysalids of each brood which retain their inmates until spring; noting every instance of the partial retention of the chrysalis, to discover to what extent pupae, apparently destined to hibernate, disclose the butterfly the same season; and, further, to determine whether both marcellus and telamonides are indifferently produced from any of the broods of the previous year. Mr. Meldola's studies would lead us to conjecture that marcellus is generally produced from the later broods of ajax, and telamonides from the earlier broods of the same, and from telamonides and marcellus; but Mr. Edwards's experiments show that this is not invariably the case. The postures of the butterfly have not been described.

LIST OF ILLUSTRATIONS.—IPHICLIDES AJAX.

General.		Chrysalis.	
Pl. 98, fig. 7.	Distribution in North America.	Pl. 85, fig. 11.	Colored.
88: 8.	Trogus exesorius, a parasite.	12.	Outline.
Egg.		Imago.	
Pl. 66, fig. 5.	Outline.	Pl. 15, fig. 11.	Both surfaces.
Caterpillar.		35: 28-29.	Male abdominal appendages.
Pl. 73, fig. 12.	Caterpillar at birth.	41: 1.	Neuration.
78: 14.	Mature caterpillar.	56: 9.	Side view, with head and appendages enlarged, and details of leg structure.
80: 13-16.	Front view of head, stages II-V.		

JASONIADES HÜBNER.

Jasoniades (pars) Hübn., Verz. bek. schmett., 83 (1816).	44 (1872). (Not Euphoeades Hübn.)
Euphoeades Scudd., Syst. rev. Amer. butt.,	Type.— <i>Popilio glaucus</i> Linn.

A wild rose tree
Pavilions him in bloom, and he doth see
A bud which snares his fancy; lo! but now
He plucks it, dips its stalk in the water: how!
It swells, it buds, it flowers beneath his sight;
And, in the middle, there is softly plight
A golden butterfly; upon whose wings
There must be surely character'd strange things,
For with wide eye he wonders, and smiles oft.
Lightly this little herald flew aloft,
Follow'd by glad Endymion's clasped hands:
Onward it flies. . . .

Still his feet
Went swift beneath the merry-winged guide,
Until it reached a splashing fountain's side
That, near a cavern's mouth, forever pour'd
Unto the temperate air; then high it soar'd,
And, downward, suddenly began to dip.
As if, athirst with so much toil, 'twould sip
The crystal spout-head: so it did, with touch
Most delicate, as though afraid to smutch
Even with mealy gold the waters clear.
But, at that very touch, to disappear
So fairy-quick, was strange!

KEATS.—*Endymion*.

Imago (57: 4). Head large but proportionally smaller than in the other genera of Papilioninae, covered densely, in front of the antennae, with rather long, equal, forward and upward directed hairs, behind them with short pile. Front (61: 13) somewhat tumid, scarcely more so just below the middle, excepting above projecting somewhat and almost equally beyond the front of the eyes; excepting above, the sides of the front are scarcely lower than the eyes; next the border, on the upper third, is a faint sulcation, diverging, directed toward the inner edge of the antennae; below the antennae the front is scarcely broader than high, and slightly broader than the eyes on a front view; the upper border projects rather narrowly between the antennae; lower border rather strongly and largely rounded. Vertex somewhat tumid, particularly at the sides, forming a very low and broad curving ridge, similar to Euphoeades, very slightly depressed on either side of the middle, the portion in front of the ridge depressed, nearly flat, ridged around the inner side of the antennae, and slightly where it meets the front. Eyes very large, very full, naked. Antennae inserted with their anterior edge in the middle of the summit, separated by half the diameter of the second antennal joint; slightly larger than the abdomen, composed of forty joints, each thickened a little at the tip, the apical twelve of which are not only flattened but a little channelled, leaving the joints broader above than beneath; viewed from the side the club increases in size so gradually as to make it difficult to determine its com-

ment, is afterwards uniform and diminishes more rapidly on the last four joints to a bluntly conical apex; viewed from above, the increase and diminution are very similar in character and extent, giving the club a fusiform appearance, the tip bluntly pointed; the club is twice as broad as the also compressed stalk, and eight times as long as broad; under edge serrate on a side view and very broadly and shallowly channelled on the outer side, and very distinctly, rather narrowly and deeply grooved on the middle of the inner side. Palpi very minute, rather slender, reaching the middle of the front of the eye and heavily fringed with very long, erect hairs.

Prothoracic lobes obsolete. Patagia rather small, scarcely arched or tumid, curved slightly outward, three times as long as broad, the basal half equal, the apical tapering very slightly to a very bluntly pointed apex.

Fore wings (40:10) scarcely twice as long as broad, the costal border very slightly convex previous to the apical sixth, where it curves downward considerably; outer border straight, rounded off a very little at either extremity, and having a general direction at an angle of about 40° with the middle of the costal margin; inner margin scarcely concave, rounded off at the tip. First superior subcostal branch arising just before the middle of the outer half of the cell; second midway between this and the apex of the cell; third at the apex; and fourth at one-third the distance from the apex to the outer border. Cell considerably more than half as long as the wing and three and one-half times longer than broad. At the origin of the fourth median branch the main vein is raised above the continuation of its basal half by the width of the last median interspace at its base. Cross vein connecting the median and submedian veins near the base directed outward in passing downward.

Hind wings with the costal margin considerably and roundly shouldered next the base, beyond nearly straight, slightly convex, curving downward to meet the outer border at the apex, which is well rounded off; outer margin strongly crenulate, the lower half greatly produced, the upper half broadly rounded, more so in the ♀ than in the ♂, and fullest though rather more rounded at the angle in the former, at the upper median nervule prolonged to a very long and nearly equal tail, a little expanded interiorly at the tip, the apex well rounded, four or five times longer than broad; posterior to the tail the border recedes slightly and has an emarginate angle and a slightly concave inner border, quite as in Papilio. Subcostal nervule nearly straight between the bases of the first and second nervures; vein closing the cell slightly shorter than the distance between the bases of the second and third median nervules.

Fore femora and tarsi of about equal length and a third longer than the tibiae; middle tarsi but little longer than the tibiae and about four-fifths the length of the femora; hind femora, tibiae and tarsi of very nearly equal length; femora differing but slightly in length, the middle pair longest; hind tibiae a fifth longer than the middle tibiae or three-fifths longer than the front pair; fore and middle tarsi of nearly equal length (in the female shorter in the middle legs) and about five-sixths the length of the hind tarsi. Femora with a moderately long brush of thin, spreading hairs beneath. Tibiae furnished on either side beneath with a row of not very frequent, short, and moderately slender spines; just within the inner row a few other scattered spines, and on the upper portion of either side a double row of frequent but otherwise similar spines; at the apex beneath a pair of very long and slender spines, the inner a little the longer. First joint of tarsi scarcely equalling the length of the three succeeding joints taken together; these scarcely differing in size, the fifth slightly longer than any of them; all armed beneath on either side with a row of rather infrequent, very short, moderately slender and almost curving spines, the apical spines of each joint no longer, scarcely stouter, but a little more curved than the others; above with four equidistant rows of scarcely more frequent, smaller and slenderer, nearly recumbent spines; claws long and very slender, compressed, strongly and largely heeled below at the base, the basal half nearly equal and nearly straight, the apical half tapering to a delicate point, and considerably and regularly curved; paronychial and pulvilli absent.

Hook of eighth abdominal segment of the male expanding considerably basewards, the part beyond rather stout, its extremity subspatulate. Valves large, irregularly

ovate, nearly twice as long as broad, armed within by an inferior, corneous rod, strongly curved upward in the middle and furnished with a very long, thorn-like denticle before the middle and at the tip two or three smaller ones.

Egg. About a fourth broader than high, well rounded, the base very broadly truncate, being more than three-quarters the greatest width, the summit with but the narrowest depression; surface clean with a rather coarse, microscopic tracery, the floors of the cells with granulations.

Caterpillar at birth. Head large, smooth, broader than high, of equal depth throughout, but thinning above, well rounded, with a slight median depression. Basal mammiform joint of antennae large but not high; third joint cylindrical, moderately slender, more than twice as long as broad; fourth minute, the bristle twice as long as the third joint.

Body largest at the second thoracic segment, behind which it tapers gradually and regularly; first segment transversely ridged with a pair of very large, lateral tubercles directed outward and upward, and provided with six or eight scattered, hair-bearing warts. The other appendages, consisting of slender, tapering bristles, enlarged at the tip to an oval club, broader than the base of the bristle, seated on simple papillae or compound tubercles, arranged as follows: a distant subdorsal series of minute papillae on the anterior portion of the second thoracic to eighth abdominal segments, each bearing a very short bristle not more than one-fourth the length of the segment; a lateral series of conspicuous tubercles, largest on the second and third thoracic and seventh and eighth abdominal segments, centrally placed and provided with three or four hairs, one conspicuously longer than the rest, considerably exceeding the length of a segment, and distinctly clubbed; a suprastigmatal series of tubercles with a cluster of hairs, not more than two or three in the middle segments; and a similar infrastigmatal series with three or four hairs to a tubercle.

The lower series are not shown, nor the middle tubercles of the lateral series, in the figure (76: 28) we have copied from Edwards, and the lateral series is represented too high; in the last respect, Gruber's figure is equally faulty.

Mature caterpillar. Head rather small, broadest at the upper limit of the ocellar field, scarcely narrowing on the sides, which are slightly compressed, the summit broadly arched and in the middle slightly depressed at the suture; considerably broader than high, deepest at the middle of the ocellar field, becoming much shallower above, the front appressed and even a little hollowed, the triangle being sunken, the sutures slightly impressed; triangle small, scarcely so high as broad, the summit rounded, reaching rather less than half way up the front, the lower outer corners sunken. Head rugulose, with irregular, tortuous, transverse, finely impressed lines, and covered profusely with very short hairs less delicate next the hinder edge. First joint of antennae, large, mammiform; second, very short; third, about two and one-half times longer than broad, tapering very slightly in the basal half, beyond equal; fourth, minute. Ocelli six in number, of which four form a pretty strongly curving row, its convexity forward and a little upward, at regularly increasing distances apart from above downward, the lower two separated by about their own diameter, a fifth, below these at the hinder base of the antennae, on a line with the lower two and distant from the lowest as far as the latter is from the next but one above it; the sixth is behind the curved row, at about equal distances from its uppermost and lowermost member and forming, with them, slightly more than a right angle; ocelli of about equal size and somewhat prominent, those of the arcuate row the most so. Labrum not very large, quite narrow, the front well rounded, its middle very sharply and angularly excised, nearly to the base; mandibles moderately large, quite broad and stout, the edge straight and smooth, the inner maxillary palpus rather larger than the outer, both very short, closely resembling each other, the ultimate joint very small, about as long as broad, the penultimate rather longer than broad and slightly larger at tip than at base. Spinneret rather large, moderately long, tapering.

Body tumid on the anterior half, including the thoracic and first two abdominal segments, the arch being about equally curved at either extremity; behind this

swollen portion the abdominal joints taper regularly both in height and width, the terminal segment viewed from above being well rounded, but slightly and roundly emarginate at the tip; the penultimate segment has a posterior transverse fold, inclined backward, produced on either side of the dorsum into a slight, appressed elevation, ending with a very small, rounded tubercle; a scarcely elevated tubercle is also found on the first segment just beyond and behind either end of the osmaterial orifice; the body is abundantly but not at all profusely covered with exceedingly short and fine hairs, although it is to all appearances naked; the terminal segment has longer ones behind. Osmaterium proportionally longer than in *Papilio*, forked almost from the very base, curving backward and a little outward, the forks parting at about a right angle. Spiracles small, obovate, nearly twice as long as broad. Legs very broad and short at base, the last three joints rather slender, not very long, tapering, appressed, the claws moderately large and stout, hooked at the base, curved uniformly and considerably, compressed, tapering. Prolegs very short and very stout, rounded at tip, scarcely tapering, provided at tip with a scarcely curving, double row of about sixty hooklets, the exposed portion being cylindrical, moderately stout, tapering but slightly, bluntly pointed, pretty strongly curved.

Chrysalis. Body nearly uniform, cylindrical, tapering posteriorly, anteriorly provided with angular prominences, throughout rugulose. Viewed from above, the sides of the abdomen, which occupies more than two-thirds the length of the body, are regularly and very slightly convex on the basal four segments; beyond, tapering gradually and regularly; the sides of the thorax are straight and very slightly divergent anteriorly behind the basal wing tubercle; in front of it greatly narrowed and tapering a little forward to the base of the ocellar prominences. Viewed laterally the anterior portion of the thorax slopes in a nearly straight line upward and considerably backward, in continuation of the anterior part of the ocellar prominences and at an angle of about 55° with the lower surface. Behind the mesonotal tubercle the upper surface is nearly straight, barely convex, as far as the tip of the fourth abdominal segment, and at an angle of about 120° with the front portion, the mesonotal tubercle intervening; the upper surface of the movable segments of the abdomen very broadly rounded; under surface, as far backward as the tips of the wings, slightly curved, very slightly bent a little way beyond the middle of the wings, more nearly straight than in any other of the subfamily; abdominal segments scarcely curved beneath, tapering as on a superior view; surface of the head flattened both above and beneath, below a little tumid in the middle, above with a pair of minute, irregular, subdorsal tubercles in the middle; ocellar prominences pretty large, irregular and rugose, subpyramidal, trigonal, having a general divergence of a right angle, the edges, and especially the superior one, strongly carinate, the superior face turned upward and considerably inward and backward, slightly broader than long, its inferior edge straight, minutely tuberculate at the base, its superior and apical rounded but a little prominent in the middle, minutely tuberculate at the base, uniting with each other along the front margin of the prothorax; in the middle of the front between the prominences narrow, pretty deeply notched; lateral face of the prominences, with the inferior carina straight, the superior bent at an angle of about 55° with it, the upper portion bent laterally at a pretty strong angle; viewed from beneath the inferior carinae are slightly bowed laterally and extend to the most posterior point of the head; the prothorax is not regularly arched transversely, the middle portion being flattened and slightly hollowed, the sides deeply hollowed, both the anterior and posterior edge raised slightly; the mesothorax is tumid, furnished at about the middle of its anterior half with an abrupt, pretty large tubercle, directed upward and slightly forward, very rugulose, subtrigonal or broader behind than in front, scarcely tapering, docked at summit, broader than high, the posterior surface hollowed, its edges strongly and roughly carinate, the carinae diverging at right angles backward as far as the laterodorsal line and then bent, extending straight backward two-thirds the way to the posterior edge of the segment, diverging again a little and fading out as they approach the margin; the basal wing tubercles are nearly as large as the mesonotal tubercle, rudely trigonal, the

posterior face largest, the tubercle directed almost wholly forward; the ridge upon the sides of the body is represented behind this only by a small, rough, not expanded tubercle, just behind and below the spiracles of the second and third abdominal segments and by a series of infrastigmatal, minute warts, immediately beneath the spiracles of the succeeding segments; a good many minute warts are scattered over the second to the fourth abdominal segments, and in addition to these there is a laterodorsal series of larger, rugulose warts on the metathorax and the first and fifth to ninth abdominal segments, a low, lateral tubercle on the metathorax and an indistinct series of clustered lateral warts on most of the abdominal segments; on the seventh and succeeding segments the abdomen is indistinctly ridged along the laterodorsal and infrastigmatal lines; median portion of the preanal button swollen, terminating anteriorly in a broad, recumbent, forward directed, depressed lobe, notched in the middle. Crenaster pretty long and broad, twice as broad beneath as above, tapering considerably, docked at tip, quadrilateral, the edges broadly and greatly carinate, between which the surface is deeply hollowed, excepting beneath where it is flat and broad, the apical field of a similar shape, the area of the hooklets transversely and broadly ovate or quadrangular. Hooklets about 125-150 in number, shaped as in *Euphœades*, but not so long or large, with a proportionally larger cup.

Jasoniades and *Papilio* are the only genera of swallow-tails peculiar to temperate regions. *Jasoniades* is further confined to North America if we except a single species, the *Papilio antinous* of Donovan, of which a single specimen has been reported from Australia; a species which Doubleday regarded as the same as our *E. glaucus*; several species occur in the New World but only one east of the Mississippi which has, however, an immense distribution, from Alaska in the northwest to Florida in the southeast. Its northern distribution, given in detail under the species, is also the limit of the generic dispersal, but other species are found south of these boundaries; none occur in the Antilles and probably none on the continent south of Mexico.

The butterflies are large, often among the largest of the old genus *Papilio*; the outer border of the fore wings is nearly straight; the hind wings are provided with from one to three tails, generally rather long and spatulate, and where the wing is not tailed the border is wavy. The ground color is yellow (in one species a secondary female is so suffused with black as almost entirely to have lost every trace of yellow), transversely striped and broadly bordered with black, the border enlivened by small, submarginal, yellow lunules; the fore wings have four stripes which are always heaviest next the costal border and often not longer than the width of the cell, but the innermost, which crosses near the middle of the cell, always traverses the entire wing and is continued upon the hind wings as a narrow, tapering stripe running toward and almost reaching the anal angle. A pseudocellus is found at the anal angle and beneath, where the markings of the upper surface are repeated; the black border of the hind wing is more or less heavily powdered with bright blue scales. The genus is peculiar among our *Papilioninae* for the brevity of the middle and hind tarsi, the rather unusual length of the hind femora and the equality of the three principal members of the hind legs.

The transformations of several species are well known; the insects hibernate as chrysalids and are single or multiple brooded, according to latitude. The eggs, which hatch in a little more than a week, are laid singly and the caterpillars live in solitude on a great variety of angiospermous plants; they spin a silken web over a whole leaf and draw the sides together, making a trough in which they lie when not feeding. The chrysalids hang for about a fortnight in midsummer. The butterflies frequently congregate in great numbers.

The eggs closely resemble those of *Euphœades* in general form and appearance. They are not smeared with any coating.

In the juvenile larvae the second thoracic segment is the largest and behind this the body tapers regularly and is covered with a few longitudinal rows of warts and tubercles mostly provided with hairs, those on the tubercles often clubbed at the tip. The mature caterpillars closely resemble in form and markings those of *Euphœades*, but have a transverse, yellow stripe bordered with black at the incisure between the first and second abdominal segments.

The chrysalids, however, differ considerably from those of *Euphœades*, approaching rather those of *Papilio*. They are nearly straight with very little fulness to the attinger edges of the wings; on the mesonotum is a small, tuberculate prominence facing forward; similar parallel ocellar prominences occur on the head, and a row of small, laterodorsal tubercles on the abdomen. It is generally gray-brown in color, sometimes green, always streaked with blackish, and resembles a rough bit of bark.

EXCURSUS XLIX.—MELANISM AND ALBINISM.

And whatso else of vertue good or ill
Grew in this Garden, fetent from farre away,
Of everie one he takes, and tastes at will,
And on their pleasures greedily doth pray,
Then when he hath both plaid, and fed his fill,
In the warm Sunne he doth himselfe embay,
And there him rests in riotous surbaunce
Of all his gladfulness, and kingly joyaunce.

SPENSER.—*Macopotmos*.

VARIATION in the coloring of butterflies sometimes shows a definite tendency, repeated in widely separated groups. Instances of this sort are melanism or melanochoism and albinism, the former terms expressing a tendency of the markings of the upper surface of the butterfly to become wholly or almost wholly black, the latter of the lighter colors, which may be normally vivid, to appear as if bleached.

As instances of melanochoism we have in our own fauna two striking examples, one the female of *Jasoniades glaucus*, where many of this sex show a tendency, farther and farther toward the south, to become altogether

black upon the upper surface; and the other, the male of *Cyaniris pseudargiolus*, in which a similar change is general in the same southern region, but in this case affecting the male sex. These two cases, belonging to different families, though occurring in butterflies of similar range in a similarly restricted district, have no other points in common. First, *Jasoniades* is a yellow butterfly, striped with black, in which both sexes are normally alike, but where in the melanic form the yellow is partially or wholly subdued, the wing becoming totally black above. In the other the sexes already differ in color, the female being paler than the male and having a broad brown margin, while the male is almost or absolutely uniform blue above; in the melanic male, however, this blue is almost entirely changed to a dark brown or to a shade similar to that bordering the wings of the female. Besides this, the melanic female of *Cyaniris* appears only in the spring brood, and here comprises all the members of that brood, at least in the southern portion of its distribution, while there is no seasonal restriction in *Jasoniades*. There are two other instances of this melanism among our New England butterflies, *Atrytone zabulon* and *Erynnis atalus*, where the upper surface of the female is affected in certain instances. These again differ from the others, first in the imperfection of the melanism and second in there being no restriction to the range of the melanic form, appearing as far as we know wherever the normal form appears and in about equal quantities; similar examples appear in allied *Pamphilidi*.

Instances of albinism are confined, so far as we yet know, to the *Rhodocercidi* (where white is a prevailing color in an allied tribe) and to the female sex. It is familiar to all entomologists, especially in the genus *Eurymus*. In some instances all the females are albinic; in others only a portion of them, but not restricted as to geographic range, though in polymorphic species relatively far more frequent in later than in earlier broods, but known to occur in all. It is found in all the *Rhodocercidi* mentioned in the body of the present work with the sole exception of *Callidryas*. Among the *Eurymi* it is far more common in the species of the subarctic and subalpine regions than in those found in lower levels or latitudes; and only here does it ever include all the females.

How to explain these phenomena is exceedingly difficult. The moment one begins to speculate, some fact appears which altogether upsets any theory he may form on the subject. Thus while this is plainly a form of colorational antigeny, which I formerly inferred was a departure on the part of the female from the normal coloring of the sex, it immediately appeared that in the case of our blue butterfly, it was the male and not the female that was melanic, in striking opposition to all the cases we otherwise know of melanic or albinic antigeny. How should this be explained?

If melanism or albinism were confined altogether to females, we might look upon it as a form of protective coloring similar to some instances we

now know of sexual mimicry; the female, as being the sex which most requires the protection, being the only one which departs from the type. Or, noticing the geographical distribution of this coloring, the melanic forms occurring altogether in the south, when they are at all limited in their distribution, the albinic forms on the other hand being far more prevalent in high northern regions, we might expect that when albinism showed itself in polymorphic species (if there were any difference between the various generations) it would prevail among those which were born in the cooler rather than in those born in the warmer parts of the year, whereas the direct opposite is the case. If, again, melanism, as largely confined to the south, be looked upon as a product of warm surroundings, we should naturally expect it in the later broods emerging in the hot season rather than in the earlier; whereas in those cases where we know of it as confined at all, it is found in the earlier, cooler part of the year.

Yet that climatic conditions have something to do with these peculiar colorational features seems almost indubitable. In the first place we may point out that melanism is almost altogether confined to the district south of the latitude of New York; and that albinism, omitting mention of high elevations, is hardly found except north of that same latitude.

In the second place, it has been shown by several naturalists, notably by Mr. J. A. Allen, that in other departments of the animal kingdom a similar tendency to melanism appears as one passes southward in North America. There is, Allen says, among American birds a general increase in the intensity of color at the southward and "an increase of the extent of the dusky or black markings at the expense of the intervening lighter or white ones, or conversely the reduction in size of white spots and bars." The cases are by no means altogether parallel, but they point in a certain definite and similar direction. This phenomenon, however, should by no means be confounded with that other which we observe in butterflies of the high north, where, as compared with the same species further south, there is a blurring of the markings upon the wings and a deepening in their tone, which presents a distinctly melanic effect, an effect which has also been produced artificially by Mr. Edwards in his experiments upon chrysalids subjected to abnormal cold. The specimens suffer in color and distinctness of marking. And here, again, we meet another difficulty: for how shall we correlate such facts as these with that of the prevalence of albinism in arctic and alpine regions.

In the third place, these antigenic qualities, which show themselves in a greater and less degree of black markings over the upper surface of the wings in butterflies, are, as far as I am aware, almost entirely confined to temperate regions, where the seasonal climatic differences are at their highest. Indeed I do not know that a single case of albinism or of melanism properly speaking occurs within the tropics, where the seasonal climatic

differences are at their lowest. By this, of course I do not mean black or white butterflies, but aberrations from the normal type of coloring in a given species, which can be signalized under these two terms. It would therefore appear quite certain that climate has much to do with the production of these strange aberrations, which seem so persistent that we are tempted, however paradoxical it may sound, to characterize them as normal. Perhaps experimentation upon our common *Eurymi* under differing and definite degrees of temperature and light during their larval stage may show the way to a solution of the question.

JASONIADES GLAUCUS.—The tiger swallow-tail.

[Tiger swallow-tail (Gosse); the swallow-tail (Packard); yellow swallow-tail (Maynard); Turnus butterfly (Harris); Turnus papilion (Emmons); Turnus swallow-tail (Saunders); large yellow butterfly (Fitch); American swallow-tail (Fitch MSS.); great black swallow-tail butterfly (Abbot); black emperor swallow-tail (Gosse); glaucous butterfly (Fitch).]

Papilio glaucus Linn., Syst. nat., 10th ed., 460 (1758).

Empoasca glaucus Scudd., Syst. rev. Amer. butt., 44 (1872); Rep. geol. N. H., 1: 350, pl. A, fig. 16 (1874).

Jasoniades glaucus Scudd., Butt., 181-182, 190, figs. 6, 153 (1881).

Papilio turnus [D'Urb.], Can. nat. geol., 11: 220-230, figs. c, d, pl. 3, fig. 1 (1857); D'Urb., ibid., v: 87, 243 (1860);—Walsh, Proc. entom. soc. Philad., 1: 352 (1863);—Edw., Trans. Amer. ent. soc., 11: 207 (1868);—Pagenst., Verh. nat. med. ver. Heidelb., n. f., 1: 101-104 (1874);—Saund., Can. ent., vi: 2-5, figs. 1, 2 (1874);—Ins. inj. fruits, 81-84, figs. 80-82 (1883);—Couper, Can. ent., vi: 91-92 (1874);—French, Rep. Ins. Ill., vii: 139 (1878); Butt., 97-101, figs. 17-19 (1886);—Middl., Rep. Ins. Ill., x: 74-75 (1881);—Coq., ib., 173 (1881);—Gosse, Trans. Linn. soc. Lond., (2) Zool., 11: 309-310, pl. 30, figs. 12-15 (1883);—Fern., Butt. Me., 25-26, figs. 1-2 (1886);—Grub., Jen. zeitschr. naturw., xvii: 470-471, pl. 7, figs. 7-11 (1884);—Papp., iv: 66-67, pl. 1, figs. 7-11 (1884);—Mayn., Butt. N. E., 54, pl. 6, figs. 70, 70a (1886).

Figured also by Glover, Ill. N. A. Lep., pl. 2, fig. 4 (3 figs.); pl. A, figs. 1, 2, ined.

JASONIADES GLAUCUS TURNUS.

The homotypic form.

Papilio antiochus Linn., Syst. nat., 10th ed., 460 (1758);—Jabl.-Herbst, Natursyst. Ins. schmett., III: 160-181 (1788);—God., Encycl. méth., ix: 19, 55 (1819);—Boisd., Spec. gén. Léop., 1: 240 (1836). [Based on an artificial specimen.]

Papilio caudatus etc., Catesb., Nat. hist. Carol., II: 83, pl. 83 (1743);—Eisenb.-Licht.

Knorr, Catesb. abbild. fische u. s. w., 83, pl. 83 (1777). [Based on an artificial specimen.]

Papilio turnus Linn., Syst. nat., 12th ed., II: 536 (1767);—Jabl.-Herbst, Natursyst. Ins. schmett., III: 136-138, pl. 41, figs. 3-4 (1788);—Abb., Draw. Ins. Ga. Brit. Mus., vi, pl. 7, fig. 3, pl. 8, fig. 4; xvi: 16, tab. 274 (ca. 1800);—Esp., Ausl. schmett., 1: 195-197, pl. 48, fig. 1 (1801);—Pal. de Beauv., Ins. rec. Afr. Amér., 119, pl. Lep. 11 b, figs. 1, 1 (1805);—God. Encycl. méth., ix: 19, 55-56 (1819);—Say, Amer. entom., III, pl. 40 (1828);—Entom. N. Amer., ed. LeConte, 1: 87-88, pl. 40 (1830);—Boisd.-LeC., Léop. Amér. sept., 19-22, pl. 6, fig. 1, pl. 7, figs. 1-3 (1829);—Boisd., Spec. gén. Léop., 1: 338-339 (1836);—Kirb., Faun. bor. Amer., iv: 286 (1837);—Gosse, Can. ent., 188 (fig.), 193, 223, 293 (1840);—Doubl., Arc. ent., 1: 143 (1845);—Lucas, Pap. exot., 35-36, pl. 18, fig. inf. (1845);—Gray, Catal. Lep. Brit. Mus. Pap., 24 (1852);—Emm., Agric. N. Y., v: 201, pl. 38, fig. 3 (1854);—Fitch, Rep. nox. Ins. N. Y., III: 23-24 (1839);—Harr., Ins. inj. veg., 3d ed., 268-269, figs. 97-98 (1862);—Morr., Syn. Lep. N. Amer., 1 (1862);—Lintn., Proc. entom. soc. Philad., III: 50-51 (1864);—Reak., Proc. entom. soc. Philad., VI: 124-125 (1866);—Saund., Can. ent., 1: 53-54 (1869).

Jasoniades turnus Hübn., Samml. exot. schmett., II, Lep. I, Pap. II, Gent. II, Arch. A, her. 2, figs. 1-2 (1820-1821).

Papilio alcidas Cram., Pap. exot., 1: 62, 151, pl. 38, figs. A, B (1779).

Papilio diurna etc. Catesb., Nat. hist. Carol., II: 97, pl. 97 (1743);—Eisenb.-Licht.-Knorr, Catesb. abbild. fische u. s. w., 97, pl. 97 (1777).

Papilio prima etc. Mouf., Ins. theatr., 98, fig. (1634).

Papilio alis amplissimis etc. Rai, Hist. ins., 111 (1710).

Figured also by Abbot, Draw. ins. Ga., Bost. soc. nat. hist., Oemler coll., 3; Gray coll., 44;—Glov., Ill. N. A. Lep., pl. 28, fig. 1, ined.

JASONIADES GLAUCUS GLAUCUS.

The antigenic female.

Papilio glaucus Linn., Syst. nat., 10th ed., 460 (1758);—Cram., Pap. exot., II: 64-65, pl. 189, figs. A, B (1779);—Jabl., Natursyst. ins. schmett., II: 229-241, pl. 17, figs. 1-2 (1784);—Abb., Draw. ins. Ga., Brit. Mus., VI, pl. 1, fig. 1; pl. 2, fig. 2; XVI: 17, pl. 1;—Esp., Ausl. schmett., I: 27-28, pl. 5, fig. 1 (1801);—Pal. de Beauv., Ins. rec. Afr. Amér., 90, pl. Lep. 1 b, figs. a, b

(1805);—God., Encycl. méth., IX: 20, 60 (1819);—Boisd.-LeC., Léop. Amér. sept., 22-23, pl. 8, fig. 1, pl. 9, fig. 1-3 (1829);—Boisd., Spec. gén. Léop., I: 333-336 (1836);—Doubt., Arc. ent., I: 143 (1845);—Chen.-Luc., Encycl. hist. nat. pap., pl. 10, fig. 1 (1853);—Gosse, Lett. Alab., 122-123 (1859);—Morr., Syn. Lep. N. Amer., 1-2 (1862). *Euphoeades glaucus* Hübn., Verz. schmett., 83 (1816).

Papilio turnus forma alt. glaucus Feld., Spec. Lep. huc. descr., 26, 73 (1864).

Papilio glaucus forma obscura Aur., Lep. Mus. Lud. Ulr., 14 (1882).

Figured also by Abbot, Draw. ins. Ga., Bost. soc. nat. hist., Oemler coll., 4; Gray coll., 45, 46;—Glov., Ill. N. A. Lep., pl. 28, fig. 8, ined

And the grasses seemed to chime
With the music's mellow bars,
While butterflies danced with airy flight
In the sunlight amber-gleaming.
And the flowers were glad that swayed
In the breeze whose tune
Was forever "June."

SCOLLARD.—*A June Harmony*

Diurnarum prima, omnium maxima.

MOUFET.

Imago (8: 1; 13: 10). Head black, the front with a slender inconspicuous line of yellow hairs on either side, not quite bordering the eyes; from the outer posterior edge of each antenna a broader, slightly oblique, yellow streak runs to the thorax, where it strikes a broader band, continuous with it. Antennae uniformly velvety dark brown. Palpi yellow with a few intermingled, long, black scales on the terminal joint.

Thorax above black, with two broad, lateral, yellow bands commencing at the termination of the yellow streak of the head, including the patagia (excepting their lower edge and extreme base), and continuing beyond in the long hairs of the metathorax; beneath yellow, black only in a moderately broad stripe, extending from the middle of the hinder edge of the eye to the middle of the thorax; coxae all covered without with yellow hairs; rest of legs dark reddish brown, the inferior surface of the femora thinly fringed with long black and yellow hairs; spines black; spurs and claws reddish.

Wings above very bright straw yellow marked with black, the veins of the fore wings, excepting sometimes the submedian and internal nervures, marked and banded with black. Costal margin of *fore wings* black, moderately flecked with yellow on the basal third, abundantly at the apical band, so as to form a line bordering the first subcostal nervule above the extremity of the cell; a black band at the base of the wing curving outward along the subcostal nervule; a broad band crosses the entire wing, narrowing slightly from above downward, nearly straight, but bent slightly at the median nervule, its borders ill-defined by an admixture of black and yellow scales, its exterior border crossing the middle of the cell and striking at (♂) or a little outside of (♀) the base of the first median nervule, its width about equal to the median interspaces; another slightly sinuous band of about equal breadth crosses the cell, its interior border striking at about the origin of the second median nervule; beyond the cell, it extends to the first median nervule or even a little beyond, narrowing as it goes, its interior border continuous with the portion in the cell, its exterior border shooting out lance-shaped lateral extensions a short distance along the second and third median nervules; the interior border of this band, within the cell, is better defined than the rest or than the first mentioned band; a third band is narrower than the previous, slightly curved outward, its exterior border well defined; it crosses the extremity of the cell, enclosing the vein at the extremity of the cell in the middle of its interior

half, and reaches from the costal border to the upper median nervule; beyond this, at the last divarication of the subcostal nervure, is another smaller, narrowing band, made up of ill defined, irregular, confluent spots, extending across the subcostal interspaces; the outer border is covered by a broad black band, as broad as two interspaces, its interior border pretty well defined and almost perfectly straight, occasionally arched in each interspace; this band includes a series of eight or nine submarginal, transversely oval, rather large yellow spots, in the middle of the outer three-fifths of the band; and, occasionally, a broad, indistinct, powdery band of very scattered yellow scales, midway between these and the interior border of the black band; fringe blackish, interrupted in the interspaces, usually on the outer half only, with an equal breadth of yellow. Base of the *hind wings* and the inner border marked by a continuous black stripe, extending over fully three-fourths of the inner border, as broad as the base of the middle median interspace, its exterior border with intersprinkled black and yellow scales, the edge of the inner border yellow; a straight, gradually narrowing, black stripe, its borders flecked with yellow scales, extending from the costal border midway between the base of the wing and the interior edge of the black outer border, and terminating at the middle of the lowest median nervule, where it is joined by an oblique spur, emitted from the termination of the internal stripe; cell narrowly bordered within with black between the second and third subcostal nervules and sometimes next a portion of the adjoining interspaces; outer margin very broadly bordered with black, the inner margin of the border starting at the costal edge, in direct continuation of that of the fore wings and directed toward a point a very little within the termination of the lower median nervule, but curving around, subparallel to the outer border, when it has reached the median nervules, and terminating a little below the extremity of the internal stripe, confused in its passage over the median interspaces by an exceedingly broad and nearly equal intermingling of black and yellow scales, which follow the nervules to a still greater distance; there is a submarginal row of four very large and conspicuous yellow lunules from the upper subcostal to the upper median interspaces, the outer limb of the lowest curving downward toward the tail; in the interspace on either side of these is a much smaller submarginal orange lunule, occasionally nearly obsolete, and next the excision of the inner border is a large, marginal, orange lunule; above the latter, midway between it and the yellow, is a strongly arched, not very conspicuous lunule of scattered nacreous blue scales; and sometimes, especially in the female, a similar or even much more extensive sprinkling of blue scales is placed midway between the submarginal lunules and the yellow main color of the other interspaces; fringe yellow, interrupted pretty broadly with black at the nervure tips, the terminal third of the inner side of the tail and the terminal three-quarters of the outer side, black.

Beneath pale, faded, straw yellow, the markings of the upper surface, excepting of the borders, repeated; outer three-fifths of costal margin of fore wings gray, with mingled brown and yellow scales; outer margin with three parallel black stripes of nearly equal breadth, the marginal one broadest, the inner one next in breadth, its interior border corresponding to the interior border of the marginal band of the upper surface; and the smallest lying midway between the two; the space between the outer two bands yellow like the ground; between the inner two, gray with equally mingled yellow and black scales; below the median nervures the black stripes coalesce. *Hind wings* with a transverse, pretty regularly curving, straight or wavy, black band, its interior border, in the median and subcostal interspaces, lying a little outside of the same band on the upper surface; it is of the width of the marginal stripe of the fore wings, but broadens on the lower half of the wing; inside of this band, there is sometimes a flush of reddish orange in the median interspaces and the second and third median nervules are sprinkled with mingled yellow and black scales; the band is narrowly and delicately bordered on the outside with bluish hoary scales, forming lunules on the lowest two interspaces; the marginal and submarginal lunules of the upper surface are repeated beneath, the paler ones often tinged with orange in the middle; between these and the blue of bluish scales, the wing is black, profusely pow-

dered with pale greenish scales; the black edging of the cell is sometimes enlivened by a median line of bluish scales; fringe as on the upper surface.

Abdomen above blue black; sides yellow to the tip, with an inferior, lateral, black stripe, broadening in the middle and tapering toward base and tip, reaching as far as the terminal segment; beneath yellow, with two subventral, narrow, black stripes; edges of the valves of the male (35:31-34) blackish, their sides yellow; the valves stout, but little tumid, broadly but irregularly rounded, nearly twice as long as broad, a little ridged along the middle, the tip slightly protuberant; the lower border is slightly sinuate, the upper a little full; the armature consists of a slender rod nearly straight in its basal half, just before the end of which it emits an inward curving and backward directed, slender, tapering spur, half as long as itself; the apical half of the rod is arcuate, bent strongly upward and a little forward, becoming expanded apically into a vertical, appressed, prominent lamina, bearing three strong, unequal denticulations directed downward, the lowest the largest and a little twisted. Just beneath the hook of the centrum is a large, fleshy, nearly colorless mass supporting a compressed, broad lamina extending to the tip of the hook; and beneath this is a corneous, slender, cylindrical, elongated member (scaphium of Gosse) curved a little downward, nearly equal, but expanding and flexible at tip, reaching in repose the inner surface of the valves at about the middle of the lower surface.

Measurements in millimetres. Length of tongue, 16 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	45.	48.	57.	47.	51.	
antennae.....	13.5	14.	16.		13.75	
hind tibiae and tarsi..	12.	13.5	14.75	12.25	13.25	
fore tibiae and tarsi..	8.5	10.	12.		10.75	

Length of tails of hind wings, 11.5 mm.

Variations and aberrations. In one female from the White Mountains (July 7) the yellow of the upper surface, particularly of the lower half of the fore wings, is slightly tinged with an orange flush.

Specimens from Alaska agree in coloration and markings with New England specimens in every particular, although they are slightly smaller than White Mountain specimens, and these are generally smaller than the average specimens from other parts of New England, and are apt to be duskier. The fore wing of one male from the White Mountains measures but 44.5 mm. and that of one female but 42 mm., while in the largest female I have from Alaska, it reaches but 46.5 mm.; one female from Alaska measures only 36 mm. in the length of the fore wing. Gosse says that Newfoundland specimens are not only smaller than continental specimens but paler. Couper speaks of those from Anticosti as darker than normal, like the Alaskan and, indeed, all others from the high north.

Many years ago I saw in some collection, but failed to note where, an hermaphrodite specimen from the south, in which the wings of the left side and the left half of the body were female, and that *J. glaucus glaucus*, while the right half was male and normally yellow; the valves were developed only on the right side. It was perhaps the same individual which is figured by Edwards, and first described by him in the Transactions of the American entomological society (II: 207).

Egg (66: 1). Minutely rugulose, when seen under a strong lens; color, when laid, of the green of the upper surface of birch leaves; afterward it becomes uniformly flecked with reddish brown, giving it a brownish yellow appearance. Micropyle rosette .237 mm. in diameter, composed in general of a multitude of very minute, usually roundish, sometimes oval, angular cells, nearly uniform in size, not increasing in magnitude outwardly, and averaging .014 mm., excepting at the centre (68: 18), where, in a space .05 mm. in diameter, the cells, though otherwise very similar, are not half that size. Height, 1.1 mm.; breadth in the middle, 1.4 mm.; breadth at base, 1.16 mm.

Caterpillar. *First stage* (76:28). Head shining piceous, mouth parts black. Body velvety black, first thoracic segment very pale purplish, its tubercles pale, third thoracic segment with a transverse, arcuate, dull whitish dorsal band; dorsum of the third, fourth and eighth abdominal segments pale greenish white. Legs and prolegs black. Length, 3.5 mm.; greatest breadth, .76 mm.; breadth at extremity of body, .6 mm.; of head, 1 mm.

Second stage (80:7). Head as in the previous stage, the mouth parts dark luteous. Body swollen on the anterior half, the third thoracic segment being largest; dark reddish brown, a little mottled with obscure yellowish and blackish; first thoracic segment yellowish brown, the sides and dorsum of the third abdominal, the dorsum of the fourth, a triangular anterior dorsal patch on the fifth, and the dorsum of the seventh abdominal segments, as well as the tip of the terminal segment, milky white; tubercles of the first thoracic segment similar to, but no more conspicuous than those of the first stage; a lateral row of conical warts, developing into tubercles on the eighth abdominal segment, bearing very short hairs; a pair of small laterodorsal shining warts on the third thoracic segment; below the lateral tubercles of the same segment a narrow, longitudinal, velvety black streak; and just above the lateral tubercles of this segment and of the first and fifth to seventh abdominal segments, a minute, circular, bluish white spot. A little fold can be thrust out of the dorsum of the first thoracic segment, the first indication of the osmaterial. Legs black; prolegs dark bluish white, milky white at tip. Length, 6.75 mm.; greatest breadth, 1.75 mm.; breadth at eighth abdominal segment, 1.2 mm.; breadth of head, 1.3 mm.

Third stage. Head (80:8) blackish castaneous, black above and behind; front of first thoracic segment dull purple; rest of body glistening, dark, olive green, blotched irregularly with pale olive green; the posterior half of the third, the whole of the fourth and a narrow, dorsal part of the fifth abdominal segments, with a common, cream-colored, dorsal patch, extending down nearly to the spiracles. The dorsum of eighth abdominal segment pale green; a very pale, stigmal line, inconspicuous except on the thoracic segments; beneath it the body is bluish green. The larger tubercles of the front part of body blackish luteous, those of the hinder extremity pale or whitish. Osaterial reddish brown. Spiracles black. Prolegs pale bluish green. Length, 9 mm.; greatest breadth, 2.5 mm.; breadth of head, 2.2 mm.

Fourth stage. Head (80:9) pale reddish; antennae pale, ocelli black; mouth parts paler than the general tint of the head. Body: the thoracic and first two abdominal segments dark olivaceous, the first two abdominal segments dotted with brownish, the next two pale yellowish, the third marked in the middle anteriorly with dark olivaceous, the fourth similarly marked on the sides posteriorly; the fifth to seventh abdominal segments dark brownish olivaceous, the fifth with a small, anterior, dorsal, yellowish spot; the eighth and ninth yellowish above, olivaceous on the sides, a large olivaceous spot occupying the middle of the two segments jointly; the edges of the segments are bluish green, excepting the division between the first and second abdominal segments, which is ferruginous. Whole body beneath the spiracles pale bluish green; above them dotted with indistinct, shining spots; the third thoracic segment with a transverse row of slightly raised ferruginous warts placed in the centre of the segment, together with small, roseate spots, also placed centrally in the lateral and supralateral line, edged faintly with black and with a short, longitudinal, black line between them; first abdominal segment with a pair of subdorsal, slightly elevated warts, placed anteriorly, and a transverse row of four faint, roseate spots, like those of the previous segment, placed posteriorly; the fifth to seventh abdominal segments with similar subdorsal spots; the eighth and ninth segments with subdorsal, elevated, hairy, yellow warts, that of the eighth minute, that of the ninth much elongated, situated on a transverse fold; lips of the osmaterial orifice on the first thoracic segment yellowish. Spiracles pale luteous, edged very narrowly with pale testaceous. Legs pale, the tip of the claws infuscated. Prolegs pale bluish green. Length, 21.5 mm.; greatest breadth, 4 mm.; breadth posteriorly, 2.5 mm.; breadth of head, 3 mm.

During the progress of this stage a considerable change takes place, the body, and

especially the thoracic segments, gradually changing to a purer green color, and losing the olivaceous tints, excepting a slight amount on the dorsum of the second and third abdominal segments; the dorsum in general has become deeper green than the rest of the body, the sides being scarcely darker than the under surface; there is a delicate, pale, stigmatal line, and in place of the pale markings of the third to fifth abdominal segments there is a pale yellowish or straw-colored V-shaped spot, its ends thickened, directed forward and connected with the yellow, fuscous-tipped tubercles of the ninth segment by an interrupted, faint yellowish line; on each side of the third thoracic segment is a small, lateral, pale yellowish spot, including below a luteous wart; above, a short, longitudinal, velvety black streak; and in the middle a circular black-rimmed, turquoise spot; the posterior edge of the dorsum of the first abdominal segment is yellowish.

Last stage (76:15, 26). Head (80:10) delicate ferruginous, mottled below, and especially at the sides, with pale; lower part of triangle pale; antennae pale; tip of third joint fuscous; ocelli black in a black field; labrum pale; mouth parts pale, the tip of the mandible reddish.

Body nearly uniform rich, deep green, paler below the spiracles, speckled throughout with indistinct, pale dots, which on the sides sometimes become confluent and form faint, linear, irregular streaks, having a general direction from below backward and upward; faint streaks also radiate from the spiracles; a narrow, yellow stripe, bordering the osmateral fold, sometimes extends backward, forming a stigmatal line across the thoracic segments; third thoracic segment with rather a large, lateral, subquadrate, greenish yellow spot, delicately but distinctly edged with black and having within it above a black streak, and centrally a small turquoise spot broadly annulated with black; upper surface of the first abdominal segment edged posteriorly with yellow, and the second anteriorly with black; fourth abdominal segment with a lateral, anterior, broadly oval, oblique, salmon colored spot, sometimes obsolete, extending slightly on the succeeding segment; the papilliform warts of the eighth abdominal segment and the superior portion of the transverse fold on which they are seated, lemon yellow, sometimes green; the first, second, fifth to seventh abdominal segments with a laterodorsal and lateral row of small, circular, dark turquoise or pure blue spots, those of the posterior segments faintly rimmed with fuscous; the lateral spots of the third thoracic segment are in the yellowish spot already described, and the laterodorsal ones are just above; third to eighth abdominal segments with an infrastigmatal row of pale turquoise spots, smaller than the others, centrally placed; under surface of the body pale green. Body very sparsely covered with very delicate, short hairs; osmaterium dark orange; spiracles luteous. Legs pale green, claws fuscous. Prolegs pale green.

After the evacuation preceding pupation the larva becomes of a dull, dirty, velvety green on the thoracic and first abdominal segments; posteriorly it is grizzly green, laterally streaked with fuscous. Length, 50 mm.; greatest breadth, 10 mm.; breadth behind, 4.5 mm.; breadth of head, 4 mm.

Chrysalis (85:1-4). Yellowish griseous, with a faint, dull olivaceous tinge; dorsum of the fourth to sixth abdominal segments a little more infuscated than the rest; in some specimens the lower portion of the sides of the dorsal surface is more distinctly yellowish and brighter than elsewhere; ocellar prominences, excepting in front, blackish fuscous; wings dotted and finely streaked with blackish at the outer borders and in the middle a few parallel, short, narrow, longitudinal, blackish streaks; tongue and parts of the legs adjacent to it, dusky; mesonotal tubercle tipped with blackish; a broad, irregular, blackish fuscous band, deepest in tint on the prothorax and the second to fourth abdominal segments, extends along the side of the whole body from the base of the ocellar prominences to the last abdominal segment, stigmatal in position on the abdomen; anal hooklets black. Length, 33 mm.; tips of ocellar prominences apart, 4.5 mm.; breadth of third abdominal segment, 9 mm.; height of second abdominal segment, 9 mm.; distance from mesonotal tubercle to tip of ocellar prominences, 7.5 mm.; depth of the frontal notch, 1.25 mm.; length of hooklets, .14 mm.; breadth of their apical cup, .05 mm.; mass of hooklets, 1.08 mm. long and .52 mm. broad.

Specimens are occasionally found in which there is a strong prevalence of bright, grassy green, the body being tinged and streaked with it, especially on the wings, the front of the ocellar prominences, the sides of the thorax, and a very broad band on the sides of the abdomen; even the blackish markings are then tinged with green.

Geographical distribution (26:8). This butterfly is more widely distributed than any other of our swallow-tails, for it is found in nearly every part of North America, from Atlantic to Pacific, from Newfoundland to central Florida, and from Alaska to California. In the United States it is probably wanting in the southern half of Florida (it has been taken as far south as Indian River (Schwarz, Palmer), the Great Basin region and southern California and (perhaps) the sea-coast of Alaska. It has been occasionally taken in the eastern Rocky Mountains of Colorado. Whether it penetrates into Mexico is unknown; in British America it is evidently found in all the district between Fort Yukon at the borders of Alaska to Fort Simpson on the Mackenzie* and thence to the Athabasca region (Geffcken), Lake Superior and all the settled parts of Canada, on one side, and to the United States boundary on the other. It is found on the lower Albany River at the southern extremity of Hudson Bay (Doubleday), but does not occur in any part of Labrador, first appearing on the north shore of the St. Lawrence at Godbout River (Corneau), though it occurs in Anticosti (Couper), was found "extremely abundant" by Bell on the south side of the Gulf of St. Lawrence between Cape Chat and Martin's River, and extends to Newfoundland (Gosse) and Nova Scotia, though not known at Cape Breton. That is, its northern limit in the eastern half of North America closely follows the dividing line between the Canadian and Hudsonian faunas, as laid down by Allen.

In the Gulf States the dark form of the female occurs to the exclusion of the yellow; it prevails as far north as West Virginia and southern Illinois; a little further north it begins to be rapidly supplanted by the yellow female, but straggling specimens have been occasionally taken in the east on Long Island (Graef), the vicinity of New York (Angus), Staten Island (Davis), Newburgh (Edwards) and Poughkeepsie, N. Y. (Stevenson),† New Jersey (Andrews), Delaware (Doubleday), and northern Ohio (Foster); while the further west one goes, the further north it is found. Thus Dr. Hoy has taken several specimens at Racine, Wis., one at the mouth of the Wisconsin River, and one was taken by Allen in central Iowa. At Omaha, Neb., the dark form prevails and is as numerous as the other as far north as the Niobrara River (Bruner), while it has been found near Fort MacLeod in British territory (Lat. 50°) by Captain

*The statement that it had been seen in numbers with the yellow form in the Adirondacks of New York (Can. ent. xvi:178 etc.) has been followed to its source, and specimens obtained. *Papilio polyxenes* was in this

instance mistaken for the dark female of *J. glaucus*.

† It has latterly been brought by Dr. Dawson from the Upper Liard River.

Geddes, that is, on the same parallel as the limit of the species on the Atlantic coast. In California it has not been reported to my knowledge.

In New England this butterfly is everywhere common from the summit of Mount Washington to Long Island Sound, but it is more abundant in the northern than in the southern districts. Mr. Hill has also taken it on the summits of the highest Adirondack Mountains of New York. The dark form is totally unknown in New England.

Abundance and haunts. In its season it is in many places one of the commonest of butterflies; it appears to swarm in mountain valleys. Mr. Doubleday says that in the south it is nowhere rare, inhabiting alike the low sea board and the loftiest of the wooded Alleghanies 3-4000 feet above the sea; according to the same writer the butterflies seek the plane tree blossoms, *Platanus occidentalis* Linn. as well as those of the yellow thistle, *Cnicus horridulus* Pursh, the banana, *Musa sapientum*, and the button bush, *Cephalanthus occidentalis* Linn. Edwards says that in West Virginia the earliest butterflies

frequent the fruit trees then in bloom . . . peach, apple, and above all the wild plum. Later in the season, [they] abound on the red clover, then on the *Ascleplades* and thistles, and finally, at the close of the season, on the iron-weed, *Vernonia*. In the garden they delight in the lilacs, philoxes and zinnias. Another plant, *Catananche* bicolor with its tall mullein-like flower stalks, is also very attractive (Butt. N. A., II).

In the north, the lilac, *Syringa vulgaris*, is their particular favorite. "In the early part of a Canadian summer," says D'Urban (*Can. nat.*, ii: 225), "when the fragrant lilacs are in full bloom, it is a glorious sight to see the tiny hummingbirds flying over the blossoms in company with this splendid butterfly, which is very partial to the flowers of that plant." Elsewhere in the same journal he says that "this splendid butterfly frequently assembles in great numbers about wounds on the roots of trees from which sap exudes."

Although generally abundant, there are certain years when they become scarce; thus, Mr. Lintner noticed in Schoharie, N. Y. that not one specimen was seen in 1856; in 1857 they were often seen on damp earth in companies of ten or twelve, while in 1858 they were among the commonest of butterflies. So Mr. Edwards reports that early in June, 1877, while riding beside a creek he noticed a flat rock studded with swallow-tail butterflies, "as thick as they could stand over a space not less than four feet square"; nine-tenths of them were of this species; "when they rose it was like a cloud," and according to his computation "there were upward of 2300 butterflies in that mass." The next year he "saw scarcely half a dozen examples."

As this last reference shows, the butterfly is very fond of assembling in companies around spots of moist earth or on the edge of pools by the roadside after a rain. Gosse once saw fifteen in a space not exceeding a foot

square, and again counted fifty-two settled together; but all this is quite surpassed by Prof. F. W. Putnam's statement that he actually enclosed sixty-nine specimens at once between his two hands upon a cluster of lilac flowers. Travellers by the Canadian Pacific railway in July will hardly fail to notice the great flocks that arise from every heap of vegetable or animal refuse by the railway stations on the wilder part of the route east of Lake Superior. D'Urban writes (Can. nat., v: 87):—

On the shores of Sugar-bush lake in the township of Montcalm, on the 25th June, I counted fifty-six individuals crowded together in a space not exceeding six square inches, where a dead catfish had lain for some time, and others were constantly arriving, flying straight to the spot against the wind, as though they had scented it from afar. On several occasions more than a dozen specimens were captured at a single grasp of the hand, having become so gorged and drowsy with their disgusting repast as to be unable to fly. (Can. nat., v. 87.)

Oviposition. According to the very careful observations of Miss Clarissa Guild, the egg is laid upon the upper surface of the leaf of small trees, on the branch nearest the ground, and usually only one egg on each tree. I have also always found them in similar situations. They usually hatch in eight days, but eggs obtained at Nepigon above Lake Superior and brought to Cambridge took much longer, some of them being at least a fortnight in duration; and a pencil note on one of Abbot's MSS. says, "deposits eggs, March 19; from the eggs, April 8," or twenty days; and this in Georgia. Mr. James Angus took one hundred and thirty eggs from the body of a single female, and Mr. Edwards says they lay "about two hundred."

Food plants. *Glaucus* is one of the most polyphagous of all our caterpillars, and feeds on a dozen different families of plants, all belonging, however, to the angiosperms. Of the polypetalous division are: the tulip tree, *Liriodendron tulipifera* Linn. (Kirtland, Edwards, Ridings, Newman) and *Magnolia acuminata* Linn. (Saunders), belonging to the Magnoliaceae; basswood, *Tilia americana* Linn. (Gosse, Edwards), belonging to the Tiliaceae; hop tree, *Ptelea trifoliata* Linn. (Abbot), one of the Rutaceae; wild black cherry, *Prunus serotina* Ehrh. (Guild, Saunders, Harris, D'Urban, Boissduval-LeConte); wild red cherry, *Prunus pennsylvanica* Linn. (Lintner); choke cherry, *P. virginiana* Linn. (D'Urban, Boissduval-LeConte, Riley); wild plum, *P. americana* Marsh. (Snow), and other species of *Prunus*, such as the cultivated cherry, plum and peach (Riley), the apple, *Pirus malus* Linn. (Harris), quince, *Cydonia vulgaris* (Edwards), and probably one of the wild thorns, *Crataegus* (Smith),—all belonging to the Rosaceae. Of the gamopetalous division are: *Styrax americana* Lam. (Abbot), one of the Styracaceae; black ash, *Fraxinus sambucifolia* Lam. (Edwards), "brown ash," perhaps the same (Gosse); swamp ash, probably *F. platycarpa* Michx. according to Dr. Chapman (Abbot); white ash, *F. americana* Linn. (Snow), and another species, probably *F.*

trifoliata (Abbot); young ash shoots (Fitch), and lilac, *Syringa vulgaris* (Trouvelot), of the family Oleaceae; and the Indian bean, *Catalpa bignonioides* Walt. (Akhurst), one of the Bignoniaceae. Of the apetalous division: sassafras, *S. officinale* Nees (Stauffer, Akhurst), one of the Lauraceae; hop, *Humulus lupulus* Linn. (Lintner), one of the Urticaceae; hickory, *Carya* (Abbot), one of the Juglandaceae; "black oak," *Quercus tinctoria* (Fitch), one of the Cupuliferae; white birch, *Betula alba* Spach (Guild, Seudder, Edwards), black birch, *Betula lenta* Linn. (Fitch), and common alder, *Alnus incana* Willd. (D'Urban, Emery), belonging to the Betulaceae; poplar, *Populus tremuloides* Michx. (Gosse, Guild, Seudder, Fletcher), and willow, *Salix* (Gosse, Fletcher), belonging to the Salicaceae. Mr. Stauffer further says that he has found the caterpillars on the vine (*Vitis*), where they were "detected in biting off entire bunches of green grapes." But it is a question whether some other caterpillar may not have been mistaken for this, i. e., *Chaerocampa*. In the Rural New Yorker (xiii: 109), however, as I learn from the notes of the late Dr. Fitch, are figures of the larva, pupa and imago, apparently of this species, "found on the grape vine at Lancaster, Penn." Harris also reports taking one on the burdock, *Arctium lappa*, a composite plant, but as it changed to chrysalis at once it probably sought the plant merely for pupation. Among these numerous plants, birch and poplar appear to be the favorites in New England, *Liriodendron* in the middle states and the different species of ash in the south.

Habits of the caterpillar. When young the caterpillar bites deep excavations out of the edge of the leaf opposite to the spot where it rests, weaving a bit of carpet on another part of the leaf, to which it retires when not feeding, and arches its body, when quite young, much after the style of *Sphinx* larvae, as if impatient to assume the swollen form of the anterior part of the body which belongs to its maturer life! As soon, however, as it has moulted once, sometimes before moulting, it retires to a fresh leaf and there weaves a new carpet, generally in the middle, but if the leaf does not droop so as to enable it to rest on this carpet in a vertical or nearly vertical position, it chooses a vertical part of the leaf and rests here, head upward, so that all excrement falls to the ground and the carpet remains clean. It feeds both by day and by night, but it does not now eat the leaf it rests on, but goes off every few hours for a dinner on another leaf, and indeed the same leaf it has dined on before, always finishing one, on repeated visits, before attacking another.

Soon after it has reached its fourth stage it changes its method of constructing its carpet, and it does so only just before that remarkable change in its appearance occurs, by which it assumes the adult color and form. Being about to put on the *toga virilis* it must needs set up a new establishment. The web or hammock now woven by the caterpillar, and upon

which it rests, is scarcely at all attached to the leaf in the centre, so that its sleep is taken on a spring bed, as it were. It is formed of interlacing threads which lie to some extent across the leaf, few or none being longitudinal, though many are oblique. The carpet seems, however, to be closely attached to the leaf both toward the stem and toward the apex of the latter, but not quite so densely as at the sides, and the carpet has considerable thickness. As Gosse says (*Can. nat.*, 293):—

It spins a bed of silk so tightly stretched from one edge of a leaf to the other as to bend it up, so that a section of it would represent a bow, the silk being the string. On this elastic bed the larva reposes, the fore parts of the body drawn in so as to swell out that part, on which the eye spots are very conspicuous.

When reposing here, says D'Urban (*Can. nat.*, v: 87), "these larvae, if disturbed, rock themselves slowly from side to side, throwing out the forked, orange tentacle, which is usually concealed from view in the segment behind the head, emitting at the same time a very acrid odour." Mr. L. Trouvelot (*Proc. Bost. soc. nat. hist.*, xii: 92) gives the following lively account:—

Every one knows that this larva, when at rest, remains upon the middle of the upper part of a leaf; for this purpose a carpet of silk is spread upon the leaf by the larva. This leaf, by means of the silk, is made to curve a little. On one rainy morning I observed one of these young larvae upon a lilac bush in my garden. I certainly thought that the invention of resting in the hollow of a curved leaf on a rainy day was a very poor one, for since the bent leaf performed the office of a gutter, the water must flow through this channel, the larva be inundated and inevitably drowned, if the rain lasted but a few hours. I soon found that there were more brains in the small head than I had supposed. The larva began to move; it spun some silk from one edge of the leaf to the other, and by adding many fibres to make it strong, each new fibre shorter than the preceding, the leaf was soon made to curve more and more. I then began to understand what this laborious work was for, and I thought that sometimes small people might give lessons to larger ones. After about an hour the larva ceased to work, a real bridge was built over the torrent, and upon it laid motionless and out of danger the little larva. Would you call such an act instinct, or would you call it reason? If you call it instinct, I would say that this instinct is very reasonable.

I find the following in the late Dr. Asa Fitch's note books:—

July 17, 1876. A young apple tree three feet high, set out last spring I discover is defoliated by two of these larvae, now nearly grown, only a few fragments of green foliage remaining. I place one on a similar newly set apple in full leaf. It immediately begins spinning a web from its mouth, upon a leaf, to enable it to cling to it. The other I put on another similar apple tree, on which I notice ants are running up and down, to some curled leaves at ends of the limbs, where they have Aphides, and any of them coming to this larva, attack it, causing it to shrug spitefully to shake them off. I chalk the body of the tree towards its base, to prevent them from ascending it, and kill all the lice and ants from the curled leaves, and drench the ground at the base of the tree with water, hoping to drown and drive the ants away.

Next morning I find the first larva stationed on the leaf, holding securely thereto, standing nearly upright upon the leaf, which the weight of its body inclines almost to a perpendicular, and it is here being rocked by the leaf swinging in the wind, constantly, the worm holding securely to it, and seeming to enjoy the rocking exercise.

The other larva has disappeared from the tree, which is populated by numerous ants, which have worn a road for themselves through the chalk, and are thronging

the curled leaves at the tips of the twigs. Looking among the weeds around the base of the tree, I there find the unfortunate larva, covered with ants biting it, and clinging persistently to the tender underside and prolegs, and most of all to its mouth, which seems filled with them. The worm is shrunk and wrinkled and appears almost dead, lying motionless, yielding to its fate. I take it up and clear the ants off from it, some of them clinging to its mouth so that they are torn in two rather than let go their grip. I at last get them all off, and place it on the tree where its brother is, where, released from its tormentors, it clings to the leaves, but an hour after, returning to the tree, I find it fallen to the ground. I replace it, and it has recovered so that it begins to spin a web upon a leaf. A few hours after, I find it clinging to the leaf, which the wind is agitating briskly, it being apparently recovered and is now smooth and plump as its brother.

It has the power of using its osmateria from birth, but it is not very free with them; when half grown, the odor from them seemed to me very faint and to be not unlike that of spice bush (Benzoin) but somewhat acrid.

Mr. Fletcher has reared the larva from an egg pressed from the oviduct of the female, that is, artificially laid.

Pupation. After the complete ejection of the contents of the alimentary canal, previous to pupation, "the color of the body grows much darker, becoming dark reddish brown, the sides nearly black" (Saunders) or to "a dingy purple" (Gosse); I have described it as dull, dirty, velvety green in front, grizzly green behind streaked laterally with fuscous. It now deserts its home, and though previously of sluggish habits, "often travels, and that with considerable rapidity, many yards or rods until it finds a suitable place for its protection while in chrysalis" (Edwards).

Dr. Fitch notes of a chrysalis formed in captivity that it was attached to an apple leaf, with the thread girdling it as usual. The tip of the leaf is tied by silken threads to the next leaf above it on the same side of the stem, to fasten it securely in its upright position, the worm evidently having foreseen that its weight would cause the leaf to lop down if not thus supported.

Life history. In the north this insect is double brooded, but it is triple brooded in the Gulf States, and doubtless only single brooded in the high north and as far south as Lake Superior. It always hibernates in the chrysalis; in the south the butterflies of the different broods appear early in April, the last of June and the last of August.* In New England and the adjoining region, the first brood usually appears during the last week of May, or in the northern half of the district the first week in June; occasionally it may be seen as early as the last days of May at the White Mountains, and south of it by the middle of May, and Mr. Lintner once records it at Schoharie, N. Y. on May 13. It becomes abundant in about a week, when the first females appear, begins to grow less common after the middle of the month and usually disappears shortly after the first of July, although in northern or elevated localities it may continue in scanty

*It is found at Fort Capron (Schwarz) and at Indian River, Fla. (Palmer) as early as the last week in March, and I have seen fresh

males from Georgia (Oemler) taken as late as October 8, which looks like a fourth brood.

numbers until the middle of July. The female deposits her eggs in the latter half of June (perhaps earlier) and early in July, and the eggs hatch in eight days. The change to chrysalis occurs during July, lasts two or three weeks according to latitude and season, and the butterflies appear again in the middle of July, often while those of the previous brood are still flying. Some chrysalids continue to eclose the butterfly throughout this month, but the latest probably remain unchanged until the following spring, and the spring butterflies are the united product of both the broods of the previous year. The numerical inferiority of the second brood lends force to this hypothesis, and Mr. Edwards states that in his experience about one-half of the chrysalids of the first of the three broods of the south and west remain unchanged until the following year. The eggs of the second brood are doubtless laid in the latter part of July and early in August, and the caterpillars from them become fully grown between the middle of August and the middle of September, by which time all are in chrysalis.

Habits, flight and postures. The fondness of this butterfly for flowers has already been stated, and its taste for decaying animal matter as well; its tastes indeed range from that fondness for nectar which the poets praise as godlike, down to that of the ordure of animals, engaged in extracting the juices from which it may be easily captured. Mr. Couper relates how when living in a "shanty" in the back woods

water in which salt pork had been parboiled was thrown out on the sandy loam opposite the door, and I noticed that hundreds of *Papilio turnus* frequented this spot during favorable weather, thrusting their tongues into the moistened sand when the fluid absorbed, for which they seemed to have such an extraordinary liking, rendered them semi-intoxicated. I have seen them flying from all quarters direct for the shanty. Many of them, I believe, came from a distance of two miles at least. The spot which these butterflies visited was certainly that on which the pork water was thrown, and the effluvia resulting from this was doubtless the great source of attraction (Can. ent., v: 19).

The congregating propensity or companionableness of these butterflies has already been noticed. Their tameness is perhaps a corollary of this. Unless frightened by some attack upon them, they will allow a very near approach with apparent unconcern. Gosse is the only one who speaks of them as at all wild. When a flock feeding at a puddle is disturbed, the butterflies afterwards hover about the spot, alighting and arising again, and flying backward and forward and around the spot for some minutes before all have settled again; each has to be adjusted apparently to its neighbor, and the advent of a new claimant for place may for several times disturb all the rest, and the business of alighting recommence.

I cannot forbear quoting from the Transactions of the Vassar Brothers' institute the following remarks by DeGarmo:—

The . . . most alert and restless of all our local varieties will remain perfectly quiet, if the approach be made sufficiently gradual. They can even be picked up with the fingers

at times. But the slightest evidence of motion, especially above them, alarms them at once. I have sent a small stone near them, and witnessed every evidence of alarm. When once disturbed, they become more restless and wary. Some, as *turnus* and *troilus*, when rudely disturbed by a stroke of the net, rise high in the air, and immediately seek another resting-place, even when on their choicest feeding grounds (II: 129-130).

Another manifestation of intelligence is in their plain efforts to hide from danger. After pursuing a *turnus* for some time, and repeatedly starting it from its feeding grounds by ineffectual attempts to capture it, I have often seen it seek the dense foliage of some large-leaved tree, like the maple, hickory or tulip, and getting itself snugly ensconced on a leaf immediately sheltered by one or more others, it was apparently feeling absolutely safe. Then any ordinary degree of caution is sure to result in its capture (II: 131).

Among the [swallow-tails and others], I never saw the least spirit of playfulness. These seem to be bent on the earnest business of their lives alone, and especially the *turnus* and *troilus* wing their stately flight as if this were not a world where even a butterfly needed play (II: 133).

A bird seized a *turnus*, breaking a portion of its anterior wing, but the butterfly exhibited no alarm, and continued steadily on its way, minus a bit of wing. It evidently did not appreciate the fact that it had very nearly lost its life, or else it held life much more cheaply than the ordinary animal (II: 134).

The flight of all our Papilioninae is nearly the same, but this butterfly is perhaps peculiar for its sailing and soaring; it flies high and low, rising and falling alternately several feet at a time, usually moving about twenty feet from the ground; it flutters in and out among the branches of a tree from base to crown; or, meeting a dwelling in its flight, mounts upward, soaring high above it rather than turn in its course. It has a wayward flight and in battling against the wind it beats the air pretty vigorously, yet not so rapidly as butterflies with shorter wings; startled, it flaps its wings with intense vigor, darts from one side to the other with fatiguing irregularity, nor stops until far out of sight; yet when settled upon its favorite flowers it may be approached and readily taken with the hand.

Gosse, in his *Canadian Naturalist*, says of these butterflies: "They have a very noble appearance in flight when compared with the meaner fry; they are seen a great way off, as they come dancing through the green lanes"; they are fond of open woods, alighting frequently upon the leaves of the trees.

When at rest the wings are usually widely spread, barely raised above the horizontal, the inner border of the fore wings reaching the upper subcostal nervule of the hind pair; and a slight tremulous quiver of the wings may often be observed. The antennae, viewed from above, are straight, diverging at an angle of 50° , the tips 11 mm. apart; viewed laterally they are directed first upward, then, at a short distance from the base, bent strongly forward in a graceful curve, the main stem nearly parallel to, but raised a little above, the plane of the body, and directed very slightly downward; the club again is curved pretty suddenly upward, and the thickened tip very slightly backward, showing a tendency toward the prevailing form in the *Hesperidae*.

Dimorphism. This butterfly presents one of the most interesting examples of dimorphism known, since it is limited not only sexually but geographically; it is found only where the insect develops more than one brood, at first, where there are but two broods annually, in a very feeble way, but subsequently, and apparently only when a third brood becomes common, to such an extent that nearly or quite all the females share it and the species becomes completely antigenic. Now, though it appears to require the occurrence of a third or at least a second brood to develop this antigenic quality (which consists in almost complete melanochroism), the feature is in no way confined to these later generations but occurs, according to Edwards, to an equal extent in the spring brood from wintering chrysalids. From its geographical limitation to regions where the species is more than single brooded, we should naturally presume that this variation first arose in a summer brood. That it should have extended so as to include the spring brood to an equal extent, as appears to be the case, and yet never to include the male nor to have spread to monogoneutic regions is certainly surprising and demands study. It does not appear to me that there is the slightest ground for Weismann's presumption that this is a case of sexual selection, and Edwards seems to doubt it, since he says that "the yellow females taken by me at Coalburgh have as surely been fertilized as the blacks and have as readily laid eggs; and on the wing the males may be seen coquetting with the yellow as freely as with the blacks." Why is it not rather a case similar to others of protective resemblance or of mimicry, which is not infrequently confined to the female as to the most needy? Surely the black female must be a less conspicuous object than its gaily-banded sister to an insectivorous enemy; and its restriction to the south is in keeping with the greater abundance of examples of protective coloring in the south (where insectivorous creatures more abound) than in the north.

The exact distribution and comparative abundance of this black female has been partially told above, but the following extract from Edwards's *Butterflies of North America*, vol. ii., will still further elucidate the matter:—

In *Turnus* the males are always yellow, and to the north of a certain latitude, about $41^{\circ} 30'$ on the Hudson river, and $42^{\circ} 30'$ in Wisconsin, all the females are yellow. Below these lines, as one goes southward, the black females appear, at first but rarely, then increase gradually in proportion to the yellow, until an equilibrium is somewhere reached, apparently between 39° and 38° . But I cannot learn that, after that, the black everywhere continue to increase at the expense of the yellow, though they seem to do so in certain districts or large sections of country. In this part of West Virginia, lat. 38° , I have often taken yellow females in the garden and field, and while they seem to be never so common as the black, yet they cannot in most seasons be called at all uncommon. But I am certain that in some years, or rather in particular broods of some years, the black form does greatly outnumber the other. This was so in mid-summer of 1876. For some cause the species was exceedingly scarce in the spring of that year, quite the reverse of what usually happens. During the month of July, how-

ever, when the new brood was flying, both males and females visited a field of clover within easy reach in swarms, and I made a special point of searching for yellow females, as did Mr. Mead, who was with me, and we were both struck by their exceeding rarity. In fact, but one only was taken during the time the clover was in bloom though we must have seen hundreds of the black form. Mr. Walsh has stated that in northern Illinois both black and yellow females occur, though the black are five or six times more numerous than the yellow, judging from the careful observation of five years. But on visiting a clover field in southern Illinois he captured between seventy and eighty specimens, and every yellow one was a male. Professor Snow, in Kansas, tells me that there the black much outnumber the yellow. Mr. Aaron, at Maryville, eastern Tennessee, writes that the species is abundant, but the yellow females are very rare, while the black ones are as plenty as the yellow males. And Messrs. Boll and Belfrage, in northern Texas, and professional collectors of large experience, say that the black female is much more numerous than the yellow one. All these observers, however, allow that the yellow females are found in their several districts. On the seaboard, Mr. H. K. Morrison, also an experienced collector, who has spent much time in the southeastern states, says, "In Georgia half the females of *turnus* are black." And that he has a large number of specimens from central and northern Florida, "and about one-half the females are yellow." But that among the mountains (Black Mountains) of North Carolina the females were yellow. "On my arrival at Henry's, McDowell Co., N. C., I found the males and females, yellow form, July 15th to 30th, quite abundant and fresh. At the same place, August 25th to September 5th, I found the yellow form again abundant and fresh. I saw no black females. I caught one or two of these at Morganton, Burke Co., in July, but they were rare." Within the zone inhabited by the two forms of female, neither has been known to produce a black male, nor is such an insect known to have ever been seen; the black females produce yellow males and mostly black females, only occasionally a yellow female appearing in the brood, so far as observed; and the yellow females in very rare instances produce black females. It is not possible to distinguish a yellow male or yellow female by a black mother, from the same by a yellow mother, or the black females from each other, whether the mother was yellow or black. And, as a rule, the separation of the two forms of female is complete. Intermediate examples do sometimes occur, but they are exceedingly rare. In the hundreds of this species which I have bred, there never appeared one such, and in the field I have met but three or four.

We must refer our readers to this work itself for some exceedingly interesting speculations of Mr. Edwards upon the origin, perpetuation and future of this "black race." They are well worthy of study, but too long for insertion here.

Enemies. Many of these are referred to by Mr. Edwards, as follows :

Turnus has many enemies, birds and dragon-flies by day, and probably small owls and others by night. In spite of their expanse of wing and power of flight, the larger Libellulidae will pounce on them in mid-air and carry them away. On several occasions I have known this to happen. I scarcely ever go into the garden of a midsummer morning that I do not see severed wings of Papilios and of some of the large bombycid moths upon the ground, and can only account for so much destruction at night by crediting it to the owls, which are not at all uncommon. The eggs are always liable to discovery by spiders and ants; and when the larvae do emerge, some are destroyed by the same foes; others are stung by ichneumon flies, and either while larvae or in chrysalis inevitably perish. And when at last a chrysalis is formed, it is exposed to peril from new enemies, squirrels, mice, birds, and one would think few could possibly survive the long months of winter with such a risk of destruction. (Butterflies of N. A., II.)

To Miss C. Guild, of Walpole, Mass., is due the sole credit of first bringing to light, in 1869, an interesting egg parasite (*Trichogramma minutissimum*), the first one which had then been known to me to attack the eggs of our butterflies. By her careful and patient examination of the leaves of young birch trees, she found a number of eggs, and among them five or six which had been attacked by this parasite; they could be instantly recognized, because they had all turned of an inky black color. From the first egg some specimens were probably lost. They made their appearance the last of June, and eighteen specimens were obtained. Subsequently Miss Guild brought me five more eggs, which had been enclosed in a tight box and in which the specimens were all dead. Miss Guild thought that none had escaped, and I counted seventy-nine specimens (nine male, seventy female), making an average of sixteen to each egg. The parasites escaped by eating their way out of a minute, nearly circular hole in the side of the egg, measuring .25 mm. in diameter.

It has also long been known that the caterpillar is stung by *Trogus exesorius* (88:3), the perfect insect finally escaping from the side of the upper half of the chrysalis; Mr. E. Norton of Farmington, Conn., has also bred another hymenopterous parasite, *Copidosoma turni* (89:5). Mr. Riley's notes state that in 1871 he had bred two kinds of parasites from the pupa; and some chrysalids I obtained at Moosehead Lake, in Maine, gave me a dipterous parasite, *Mascicera frenchii* (89:23).

Desiderata. The distribution of this insect in Florida and Mexico, Newfoundland and Hudson Bay, Alaska and northwestern America needs to be better known before its exact limits can be defined. Our knowledge of the districts within which the species is double brooded and only double brooded is exceedingly scanty and vague; very likely its digoneutism shifts to polygoneutism where dimorphism appears in the female, but that is a question still open to investigation. Are there more than three broods in the extreme south? Where the dimorphism obtains, the ratio of the two forms (omitting the males) should be carefully determined for many different localities, to help determine its cause. Where not monogoneutic, the relative number of chrysalids of the early broods which prematurely hibernate should likewise be determined for many different localities. Probably the list of food plants could be considerably extended. Is the butterfly, so conspicuously striped, in any way protected by odor or nauseousness, and is the dark form of the female less subject to attack than the striped?

LIST OF ILLUSTRATIONS.—*JASONIADES GLAUCUS*.

General.
Pl. 26, fig. 8. Distribution in North America.

88:3. *Trogus exesorius*, a parasite.
89:5. *Copidosoma turni*, a parasite.

Pl. 89, fig. 23. *Mascicera frenchii*, a dipterous parasite.

Egg.
Pl. 66, fig. 1. Outline.
68:18. Micropyle.

Caterpillar.

- Pl. 76, fig. 15. Caterpillar just before pupation.
 20. Mature caterpillar, dorsal view.
 28. Caterpillar, first stage.
 80: 7-10. Front view of head, stages II-V.

Chrysalis.

- Pl. 85, figs. 1, 4. Colored.
 2, 8. Outlines.

Imago.

- Pl. 8, fig. 1. J. g. turnus, male, both surfaces.
 13: 10. J. g. turnus, both surfaces.
 35: 31-34. Male abdominal appendages.
 40: 10. Neuration.
 57: 4. Side view, with head and appendages enlarged, with details of the structure of the legs.
 61: 13. Front view of head, denuded.

EUPHOEADES HÜBNER.

- Pterourus Scop., Introd. hist. nat., 498 (1777);
 —Scudd., Syst. rev. Am. butt., 43 (1872);
 Proc. Amer. Acad. arts sc., x: 259 (1875).

- Euphoeades (pars) Hübn., Verz. bek. schmett., 83 (1816).
 Papilio (pars) Auctorum.

Type.—*Papilio troilus* Linn.

Freund, der Unterschied der Erdendinge
 Scheinet gross und ist so oft geringe;
 Alter und Gestalt und Raum und Zeit
 Sind ein Traumbild nur der Wirklichkeit.
 Träg' und matt, auf abgezehrten Sträuchen
 Sah ein Schmetterling die Raupe schleichen
 Und erhob sich fröhlich, argwohlfrei,
 Dass er Raupe selbst gewesen sei.
 Traurig schlich die alternde zum Grabe:
 "Ach, dass ich umsonst gelebet habe!
 Sterbe kinderlos und wie gering!
 Und da fliegt der schöne Schmetterling."
 Aengstlich spann sie sich in ihre Hülle.
 Schief, und als der Mutter Lebensfülle
 Sie erweckte, wählte sie sich neu,
 Wusste nicht, was sie gewesen sei.
 Freund, ein Traumreich ist das Reich der Erden.
 Was wir waren, was wir einst noch werden—
 Niemand weiss es; glücklich sind wir blind;
 Lass uns eins nur wissen: was wir sind.

HERDER.—*Die Raupe und der Schmetterling.*

Imago (57: 6). Head large, covered in front of the antennae with abundant, rather long, forward and upward directed hairs, behind the antennae with short dense pile. Front a little tumid, below somewhat protuberant and forming a slightly indicated longitudinal carina; lower half projecting considerably beyond the front of the eyes; at the sides, and to a greater degree above than below, the front is somewhat depressed below the eyes, and next the border on the upper half there is a very slight sulcation, directed toward the outer half of the antennae; below the antennae the front is fully as broad as high, and nearly as broad as the eyes on a front view; upper border projecting narrowly between the antennae; lower border broadly rounded. Vertex somewhat tumid, forming a rather strongly curving, broad, transverse ridge, opening in front, with a slight, transverse, semilunar depression in the middle, infringing on the front of the ridge. Eyes (86: 20, 21) very large and very full, naked. Antennae inserted with their anterior edge in the middle of the summit, separated by a space scarcely equal to one-third the diameter of the second antennal joint; as long as the abdomen, consisting of forty-four joints, each spreading very minutely at its tip in enclosing the base of the succeeding joint, especially upon the inner side, so as to mark the joints very distinctly; the terminal thirteen or fourteen form the considerably compressed club, flattened on the outer side, scarcely more than half as broad again as the stalk, ten times as long as broad, increasing in size so gradually as to make the limit of the club very vague, scarcely diminishing in size at the tip, excepting the apical joint, which is very abruptly conical, with a rounded apex; when viewed from above, it is but little larger than the stalk and scarcely tapers at the tip. Palpi very minute, rather slender, fringed with long, upward directed hairs, and reaching the middle of the front of the eyes.

Prothoracic lobes obsolete. Patagia rather small, long and tapering, a very little arched, scarcely tumid, more than three times as long as broad, very slightly falciform, the basal half tapering a little, the apical half forming an equal posterior lobe, half as broad as the base, with a blunt conical apex.

Fore wings (40:3) twice as long as broad, slightly shorter in the ♂, the costal margin as in Papilio, the outer margin straight or scarcely concave, having a general direction at a little less than a right angle with the apical portion of the costal border, the apical angle rounded off; inner margin straight, scarcely and rather broadly emarginate at the middle, the angle rounded off. First superior subcostal nervule arising just before the middle of the outer half of the cell; second midway between this and the apex of the cell; third at the apex; and fourth at a little more than one-third the distance from the apex of the cell to the outer border; cell a good deal more than half as long as the wing and more than three times longer than broad. Median nervure at the origin of its fourth branch raised above the continuation of its basal half by rather more than the width of the last median interspace at its base; cross vein connecting the median and submedian near the base of the wing directed straight downward until close to the latter and then turned outward.

Hind wings with the costal margin considerably and roundly shouldered next the base, beyond a little convex, apically curving to meet the outer margin so as to leave no angle; outer border strongly crenulate, greatly produced in the posterior half, the upper half broadly rounded, fuller at the angle in the ♀ than in the ♂, forming with the apical half of the costal margin a well-formed arch; at the upper median nervule greatly prolonged into a long, subspatulate tail, well rounded at tip, three or four times longer than broad, its plane, in nature, at right angles to the plane of the wing; below, the border nearly at right angles to the nervures though strongly crenulate in the ♀, receding a little in the ♂, the emargination of the angle and the inner margin as in Papilio. Subcostal nervure nearly straight between the bases of the first and second nervules; vein closing the cell a little longer than the distance between the bases of the second and third median nervules.

It is plain on comparing a chrysalis just about to emerge, with an imago, that the whole outer margin of the fore wings corresponds exactly in position with that portion of the hind wings which lies between, and includes, the tail and the anal angle; the veins of the hind wings above this all terminate on the inner margin of the wing cases.

Fore femora and tarsi of equal length and more than half as long again as the fore tibiae; middle tibiae either a very little shorter than the femora and these than the tarsi (♂); or, considerably shorter than the femora which are equal to the tarsi (♀); hind femora a little shorter than the tibiae, the latter about three-quarters the length of the tarsi; middle femora a little longer than the fore femora and these than the hind pair; middle and hind tibiae about equal and fully half as long again as the fore tibiae; hind tarsi somewhat longer than the middle pair and these about as much longer than the fore tarsi. Femora with a very short brush-like mass of delicate hairs beneath. Tibiae armed on either side beneath with a row of rather frequent and very slender, scarcely curving spines, that on the outer side forking in the middle of the tibiae and sending a branch to either side of the outer spur; also on the outer side, above, a double row of similar but rather shorter spines, and on the inner side, above, a double row of still smaller, nearly recumbent spines; at the tip a pair of very long and very slender spurs. Tarsi with the first joint as long as the three succeeding together, these growing scarcely shorter in succession, the fifth equal to the second; all armed beneath, on either side, with a row of frequent, very short and very slender spines, the apical ones of each joint about twice as long as the others; and on the basal joint, in the inner row only, five or six nearly equidistant curving spines nearly three times as long; above, four nearly equidistant rows of spines similar to the lower ones; claws very long and very slender, compressed, the basal half equal and straight, the apical half tapering to a fine point and curving slightly downward; paronychiae and pulvilli wanting.

Abdomen cylindrical but flattened beneath, of nearly uniform size throughout, bluntly

round at tip; the hook of eighth abdominal segment of male broadly expanding baseward, the part beyond slender, its extremity subspatulate; valves broad ovate, roundly angulate at tip, half as long again as broad, armed interiorly with an inferior, arcuate, corneous rod, emitting one or two large, distant denticles on the apical half and at the tip a series of smaller ones.

Egg. Nearly a third broader than high, well rounded, the base about half the width of the middle, with no sign of depression at summit; surface clean, with an exceedingly fine cob-web like tracery, the floor of the cells nearly smooth.

Caterpillar at birth. Head furnished with scattered, long hairs, the summit concealed by the folds of the first thoracic segment. Body subquadrate, tapering posteriorly; thoracic segments with a series of smooth, fleshy tubercles, one to a segment; that of the first, which is much the largest, tapers gradually to a blunt, rounded tip, is directed upwards and outwards and very slightly forward, and is supplied with a few spinous hairs. All the segments of the body furnished with a supralateral series of small, fleshy warts, one to a segment in a row, that of the eighth abdominal segment being much larger than the others, and those of the second and third thoracic and the first and seventh abdominal next in size; all bear a collection of what appear like spinous hairs, but which are slightly enlarged at the extreme apex; there is also a subdorsal series of straight, erect hairs as long as a segment, anteriorly placed, one to a segment, on all but those on the second and third thoracic and the first and second abdominal segments seated on excessively minute warts; there are, further, suprastigmatal and infrastigmatal series of compound tubercles, each with several bristles; last abdominal segment furnished only with a semicircular fringe of long hairs curving backward.

Mature caterpillar. Head moderately large, very well rounded, broadest in the middle, considerably broader than high, the sides broadly rounded, a very little full next the lower part of the ocellar area, the summit broadly rounded and in the middle a little depressed at the suture; considerably deepest next the upper part of the ocellar region, above becoming much shallower; front appressed quite regularly, flat, the sutures a very little impressed; a slight depression in the triangle at either side below; triangle fully as broad as high, scarcely reaching the middle of the front; head delicately corrugated by short, impressed, irregular, transverse lines and on the summit and sides behind furnished with a very few, exceedingly short and delicate, very inconspicuous hairs. Antennae with first joint tumid, mammiform, second very short, third nearly three times as long as broad, equal and squarely docked, fourth very minute. Ocelli (86: 24-25) six in number, four arranged in a strong curve, having its convexity forward and bounded anteriorly by a slightly impressed line, the second from the top equally distant (about its own diameter) from the first and third, the fourth at a little greater distance from the third, a fifth below these, on a line with the third and fourth and as far from the fourth as the latter is from the second; a sixth behind the arcuate row, at equal distances from the second and fourth, and forming with them a very little less than a right angle. Labrum not very large, rather narrow but long, with a deep and broad excision in the middle of the front border, forming a U, half as broad as deep, whose sides are parallel, extending half way to the base and having its extremities well rounded off. Mandibles pretty large and stout, very broad, the edge straight and smooth, at the upper extremity showing minute, transverse scratches. The outer maxillary palpus with the second joint as long as broad, the third not more than half as broad as the second, but half as long again as broad, the fourth small, conical, rounded; last joint of inner palp apparently like the penultimate of the outer but stouter and shorter. Spinneret moderately large, stout and long, conical.

Body with a general shape like that of *Jasoniades*, the swollen anterior portion including the second and third thoracic and the first and part of the second abdominal segments, being largest on the terminal thoracic segment; behind the tumid part the body tapers regularly to the seventh abdominal segment, beyond which it is equal or when the anal prolegs are drawn forward, the eighth abdominal segment is enlarged some-

what; the last segment broadly rounded at the tip and slightly but broadly flattened; a very large, though but little elevated, fleshy, lateral tubercle on the middle of the third thoracic segment, its posterior edge abrupt, its anterior sloping off gradually. The body is covered with excessively short and delicate, nearly imperceptible hairs. Osmateria comparatively stout. Spiracles oblong obovate, more than twice as long as broad. Legs very small, short, the horny joints scarcely tapering, very little appressed. Claws not large, heavily hooked at base, compressed, pretty strongly and regularly curved, tapering to a fine point. Prolegs pretty large and stout, tapering a very little, armed at tip with a slightly arcuate, triple row of nearly one hundred closely packed hooklets, the exposed portions of which are very small, short, scarcely compressed, pretty strongly curved, tapering.

Chrysalis. Long, rather slender and graceful, smooth; viewed from above, the abdomen, which occupies less than two-thirds of the body, is fusiform, somewhat truncate in front, the thorax as far forward as the basal wing tubercle equal, the sides parallel and straight, the basal wing tubercle slight, in front of which the body tapers rapidly to the base of the anterior end of the prothorax and then expands as rapidly with the sides of the ocellar prominences, the front between their tips deeply notched. Viewed laterally, the inferior surface of the wings is strongly tumid, almost bent (at an angle of about 135°) and well rounded, the anterior part of the body straight, the ocellar prominences turned slightly downward, the posterior portion of the body pretty broadly concave; the anterior part of the body from the summit of the mesothorax forward is nearly straight, inclined at an angle of about 50° with the under surface, behind the highest point of the mesothorax bent sharply at an angle of about 125° and continuing in a nearly straight line to the abdomen; then bent again at an angle of about 150° and continuing straight as far as the tip of the fourth segment; beyond this curving downward in a broad arch, but more rapidly than the under surface so that the hinder segments taper regularly and gracefully. There is a distinct carina extending along the sides of the whole body, commencing at the base of the upper carina of the ocellar prominences, passing through the basal wing tubercles, taking in their course the superior edges of the wings and then continuing as infrastigmatal carinae over the abdominal segments, a little bent at the tip of the third segment, terminating at the tip of the cremaster; it is almost equally distinct throughout. The head is flattened above and below and the ocellar prominences are very large, prominent, pyramidal, trigonal, the angles carinate, the exterior face long and slender, tapering on the basal half, beyond nearly equal, the apex rounded, those of opposite sides divergent at an angle of about 60° , occasionally of 90° , the superior face triangular, pretty regularly tapering, twice as long as the medium width, rounded at the tip; the front margin between them as broad as their length, itself slightly excised angularly, but when they are extremely divergent the anterior carinae continue to the middle of the front and are bent at an angle to each other of about 150° ; the superior carinae extend as far as the antennae, the inferior with undiminished prominence to the basal junction of the tongue and middle legs. Ocellar ribbon (**86**: 22-23; **87**: 24) kidney shaped, strongly curved. The mesothorax is somewhat elevated, the sides not rounded but sloped at an inclination with each other of a little less than a right angle, the median elevation pyramidal, trigonal, all the angles lightly carinated, the posterior face the narrowest by half. The basal wing carinae are only distinct as slightly greater elevations of the lateral carinae of the body and a slight tumidity above and below it. Transversely the abdomen is pretty broadly rounded on the expanded portion, beyond well arched; beneath broadly rounded; the sides of the wings are scarcely full, rounded at the ventral line, the sides inclined at an angle of about 70° . Preanal button obscure, terminating anteriorly in a pair of approximated, very broad and short and bluntly rounded, scarcely elevated, recumbent, depressed. Cremaster long, tapering rapidly, the tip docked, twice as broad beneath as above, transversely quadrangular, all the edges broadly and distinctly carinate, the tip of the same shape, the mass of hooklets as in *Laertias*. Hooklets about seventy-five in number, moderately large, long and slender, enlarging regularly and slightly, the outer half curved slightly, at the extremity curved strongly and pro-

duced into a rounded, cup-shaped expansion which forms a broad, blunt hook, the lateral angles of which are considerably produced and curved; anterior edge entire.

This genus is strictly American and is composed of only two or three species. It spreads over the southern half of North America east of the Rocky Mountains, including the Antilles; only one species occurs in New England.

The butterflies are larger than those of *Laertias*, and the upper median nervule of the hind wings bears a nearly equal tail, which in nature is twisted at right angles to the plane of the wing; the wings are black above, dark brown beneath; upon the outer half, above, they are furnished with one or two rows of large pale spots, and on the hind wings the spots of the inner series are merged into a broad and more or less powdery band, at the inner extremity of which is one ocellated part-colored spot; beneath, the spots of both wings are repeated, but both those on the hind wings become very large, independent and orange colored, while the field between is more or less extensively powdered with blue. Less than any other of our genera does the structure of the butterfly depart from a common type, though the sexual distinctions in the length of the legs is more than usually marked.

The insects are double brooded, wintering as chrysalids. The first brood appears early in spring, the second in midsummer; the eggs are laid singly, the caterpillars feed principally on Lauraceae and live singly in a trough made from a leaf which is partially or completely drawn together with silk. In midsummer the chrysalids hang about a fortnight.

The eggs are nearly spherical, about a millimetre in height and pale green.

The juvenile larvae are a little angulated and furnished with longitudinal series of small fleshy warts bearing spinous hairs, beside other simple hairy warts; one pair of fleshy prominences on the sides of the first thoracic segment projects forward like ears on either side of the head. The mature caterpillars are rounded and naked, green above and reddish beneath; the anterior part of the body, especially the last thoracic segment, is greatly enlarged, giving these caterpillars very much the appearance of those of the genus *Chaerocampa* among Sphingidae; the body is rather inconspicuously ornamented with several longitudinal rows of small dark round spots, often of very delicate tints, and bears on each side of the third thoracic segment a very large and conspicuous, ocellate, part-colored spot. Other large spots are found on the hunched portion, but varying according to the species.

The chrysalids are generally light colored, often with various tints of wood-brown, and are marked with inconspicuous longitudinal series of dark spots; the anterior extremity is bent a little upward, the ventral surface next the wings is produced, much as in *Callidryas* though in a far less



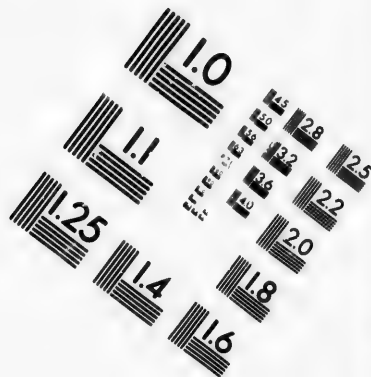
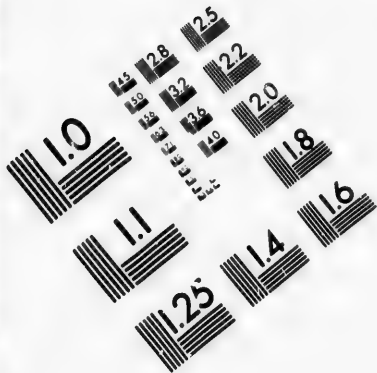
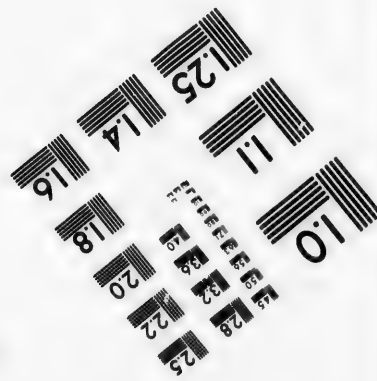
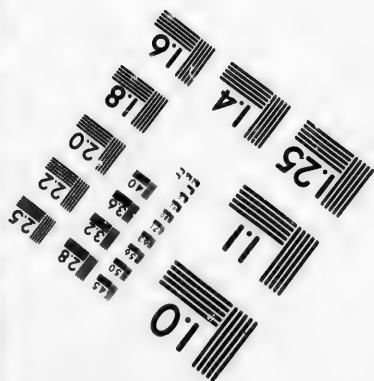
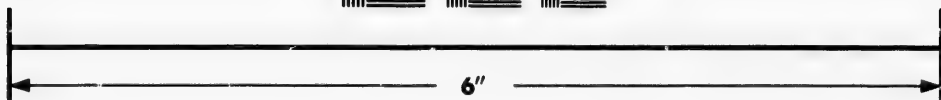
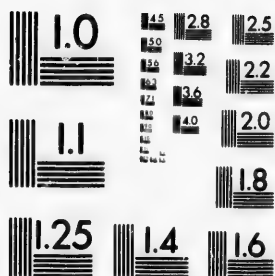


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degree; the mesonotum bears a broad, triple ridged, but not very high projection, and the ocellar prominences are large, prolonged and divergent; the sides of the body are also ridged from one extremity to the other.

EXCURSUS L.—DECEPTIVE DEVICES AMONG CATERPILLARS, OR THE DEFENCES OF CATERPILLARS.

Kriechend zaudre die Raupe, der Schmetterling elle geschäftig,
Bildsam ändre der Mensch selbst die bestimmte Gestalt.

GOETHE.—*Metamorphose der Pflanzen.*

She creeps;
Her motion and her station are as one:
She shows a body rather than a life;
A statue, than a breather.

SHAKESPEARE.—*Antony and Cleopatra.*

IN A previous excursus some account was given of the protection enjoyed by caterpillars of butterflies through their coloring and their imitation of natural objects, by which they escape detection. In the present we propose to mention some of their means of defence against foes, due to their actions or mode of life, actions which seem to be hereditary in precisely the same sense and enforced by natural selection in quite the same way as are the protective colors; these creatures act, therefore, in some sense as automata, those caterpillars not availing themselves of these defences of their forefathers being the first to be cut off, and so leaving no descendants to inherit their individual propensities.

The life of a caterpillar is full of perils from birth to maturity. Though often formidable to look at, it is nevertheless soft skinned. Though it may have a choice place of concealment or even a well constructed nest, it must roam at large while seeking food; and there are several periods of its life, when, to undergo its ecdysis, it must remain an entire day or even more, motionless and helpless and generally quite exposed. Its main purpose in life, next to feeding, is *not to be seen*.

One of the simplest devices to escape notice is that of confining all activities (which include with these gluttons scarcely anything but feeding) to the night time and retiring to some concealment during the day. This is a very common occurrence with the Satyrinae and Argynnidi in particular, the Argynnidi with their dusky clothing retiring to the surface of the ground where they are least liable to be seen, the satyrids remaining perhaps upon the stems or blades of grass or sedge which form their food and among which they are concealed by their striped attire. Or the retirement may be to the under surface of a leaf, a very common practice, which is exemplified in our own fauna by the habit, among others, of such diverse butterflies as *Polygonia faunus*, *Junonia coenia* and *Laertias philenor*.

A very common mode of concealment, however, is the construction of a

special nest for the purpose, within which they remain at all times when not feeding, and oftentimes even the greater part of their entire lives, feeding as they may do upon the nest itself until they have eaten themselves out of house and home. A good instance of this last propensity is found among the species of *Vanessa*, all of which construct more or less open nests, but devour the contents and the structure itself of the same. Others forming open nests are some of the species of *Polygonia*, while more complete web-concealments are made by the caterpillars of *Aglaia milberti* and some of the *Melitaeidi*. The mere partial curling of a leaf so as to conceal the sides of the creature lying thereon answers the purpose of *Jasoniades glaucus*, while its neighbor *Euphocades troilus* turns the leaf completely over so that the opposite edges touch. But the group, which above all others contains caterpillars living in concealment is the *Hesperidae*, the higher *Hesperidae* making an oval enclosure by strong strands of silk connecting the edges of leaves at wide intervals, while the *Pamphilidi* construct burrow-like nests by sewing together the edges of neighboring blades of grass; hardly an instance is known, where one of them lives openly.

Butterfly caterpillars which live exposed have many of them special modes of guarding against danger, some falling to the ground and curling up at the slightest shock or alarm, such as many of the *Melitaeidi* in their later stages. Others fall with greater deliberation, first attaching a thread to the leaf from which they drop, such as *Hypatus bachmanii* and *Strymon titus*. Others assume a *Sphinx*-like attitude which they may retain for a long time, as is the case with *Vanessa huntera* in its earlier life, and in this they are sometimes aided by the presence of a special knobbed process on the hunched portions, as in the species of *Basilarchia*. Others when disturbed strike with their mandibles the leaf upon which they are resting, as *Vanessa atalanta* and *Cinclidia harrisii* are known to do. Or they may move their heads from side to side, catching their mandibles in the roughnesses of the leaf, and so produce a grating sound,—a very common trick of the higher *Hesperidae*. A curious allied habit is found in *Laertias philenor*, which taps alternately with its front legs upon the leaf repeatedly when disturbed,—a habit I have seen in no other caterpillar. *Anosia plexippus* again, which, when eating, keeps its anterior flexible filaments constantly in motion forward and backward, moves them with still greater violence when it is in a state of alarm, and this must serve as a very considerable protection to it.

Nearly all caterpillars, whether of butterflies or moths, will, when disturbed, throw their heads violently around from side to side in a threatening, angry manner, the head with its hard incasement and biting jaws being the most offensive weapon in the control of the caterpillar. But it is a very curious sight to see how, as impelled by one impulse, the young cater-

pillars of some of the Nymphalidae, such as *Euvanessa antiopa*, *Aglais milberti*, and *Cinclidia harrisii*, will move their heads by simultaneous jerks to one side and the other, like a regiment of soldiers shifting arms. This community of action must be a very considerable safeguard, and indeed I am inclined to regard the mere presence of caterpillars in considerable numbers feeding in company as in itself protective, partly because it is most common in the highest family and never found in the lowest, so that the habit would seem to have grown and become intensified by its protective qualities. Some certainly of the caterpillars which thus feed in company will not be touched by chickens. I have several times thrown twigs covered with the caterpillars of *Euvanessa antiopa* into a chicken yard only to the alarm of the chickens, they either paying no attention to the caterpillars as they crawled away, or regarding them with evident horror, never once offering to touch them; of course this may be due simply to their spinous clothing. But besides the spined caterpillars which are presumably protected by such community of action, such as *Euvanessa antiopa*, *Aglais milberti*, *Eugonia j-album* and the *Melitaeidi* in their earlier stages, we have, even in our own fauna, instances of naked caterpillars which enjoy the same means of protection, such as *Chlorippe clyton* and *Laertias philenor*, especially in their earlier stages.

The greatest danger to caterpillars would seem to be when they are in motion, as they are then more readily detected by insectivorous creatures. To guard against such danger, many caterpillars, as all the *Satyrinae*, are excessively slow in their movements. Most caterpillars remain absolutely still during all times when they are not actually eating or on their way to their feeding spots, but some have the habit, in passing to and from their feeding grounds, of moving with the utmost rapidity, hurrying as if their safety depended upon it, as doubtless it does. Such are all the *Argynnidi*, and I have noticed a similar habit in *Polygonia progne*. Others, again, among the slow movers have a very peculiar trick, which I do not remember to have seen mentioned by others; it is a sort of rocking motion, not from side to side but forward and backward, moving forward by little starts; they seem to glide by little jerks in a very slow and measured way. The caterpillars in which I have noticed this habit are *Cereyonis alope*, *Eurymus eurytheme* and *Euphocaes troilus*; it is most conspicuous in the last.

Perhaps of all our caterpillars there are none which have so many means of defence in habit or protective device as the species of *Basilarchia*, and this altogether in addition to their coloring. Attention has already been drawn to this in a former excursus. It may be well, however, to summarize here some of the more peculiar ways by which it protects itself. In the first place it moves about with little starts, much as *Euphocaes troilus* and the others we have mentioned, its head all the while

trembling as if it had the palsy; then, when disturbed, it will throw the front half of its body about like a whip, lashing its sides with great violence and fury, an operation which must most effectually drive away many of its smaller foes at least. These points refer to its active movements, but besides we have its curious habit of living upon the extremity of the nearest midrib of the leaf upon which it is feeding; its construction of a pellet of ruffraff, movable with every breath of wind, apparently to distract attention from its presence; its habit of retiring after feeding (when a leaf no longer serves its purpose) to the twig of the plant upon which it feeds, where it is less easily observed; and its construction of a complex hibernaculum in which it passes the winter, to secure which from falling to the ground it securely enwraps the twig of the leaf of which it is made with silken cords to the stem.

Doubtless if the behavior of our other caterpillars had been followed more closely, many would show devices as complicated, various and interesting as those of *Basilarchia*. I have not attempted to go outside our own fauna, but here much more information is needed. We should not fail, however, to mention the almost universal habit of caterpillars to eat their cast skins, so as to remove from their immediate vicinity any traces of their presence, a habit the more marked because I believe it is not shared by any of those caterpillars which live in company, where the numbers are so great that escape from observation would be impossible, and safety lies only in their numbers. Nor have I alluded to the special protection afforded to many of the *Lycaeninae* by the presence of their friendly ants, nor to the *osmateria* or stench-throwers of the *Papilioninae*, by which they are specially protected, since in both these instances these have their seat in physiological processes, which are of a widely different nature from the mere habits under discussion.

EUPHOEADES TROILUS.—The green clouded swallow-tail.

[Green clouded swallow-tail (Gosse); green spotted swallow-tail (Maynard); orange spotted swallow-tail (Ross); Troilus butterfly (Harris); laurel swallow-tail (D'Urb.).]

Papilio troilus Linn., Syst. nat., 10th ed., 459 (1758);—(pars) Cram., Pap. exot., iii: 25-26, 176, pl. 207, figs. B, C (not A) (1782);—Jabl., Natursyst. Ins. schmett., ii: 291-293, pl. 20, fig. 2 (1784);—Panz., Drur. abbild., 55-56, pl. 11, figs. 2, 3, 5 (1785);—Abb., Draw. Ins. Ga. Brit. Mus., vi: 3, figs. 7, 8; 4, fig. 9 (ca. 1800);—Esp., Ausl. schmett., i: 21-23, pl. 3, fig. 2 (1801);—God., Encycl. méth., ix: 20, 60, 61, pl. 7, fig. 5 (1819);—Boisd.-LeC., Lép. Amér. sept., 26-29, pl. 10, figs. 1-4 (1829);—Boisd., Spec. gén. Lép., i: 334-335 (1836);—Lucas, Lép. exot., 37-38, pl. 19, fig. inf. (1845);—Gray,

Catal. Lep. Brit. Mus., Pap., 23 (1850);—[D'Urb.] Can. nat. geol., ii: 310-318, figs. a, b, pl. 4, fig. 1 (1857);—Gosse, Alab., 78 (1859);—Harr., Ins. inj. veg., 3d. ed., 266-267 (1862);—Entom. corresp., 271-272, pl. 2, fig. 1, pl. 4, fig. 16 (1869);—Morr., Syn. Lep. N. Amer., 5 (1862);—Feld., Spec. Lep. huc. descr., 28, 76 (1864);—Lluta., Proc. entom. soc. Philad., iii: 51 (1864);—Pack., Guide Ins., 247-248 (1868);—Saund., Can. ent., i: 73-74 (1869);—Pagenst., Verh. nat. med. ver. Heidelb., n. f., i: 89-90 (1874);—French, Rep. Ins. Ill., vii: 138-139 (1873);—Butt. east. U. S., 93-94 (1884);

Middl., Rep. ins. Ill., x: 74 (1881);—Auriv., Lep. Mus. Lud. Utr., 12 (1882);—Grub., Jen. zeitschr. naturw., xvii: 471-472, pl. 7, figs. 12-15 (1884); Pap., iv: 87, pl. 2, figs. 12-15 (1884);—Mayn., Butt. N. E., 49-50, pl. 7, figs. 68, 68a (1886).

Pterourus troilus Scop., Introd. hist. nat., 433 (1777);—Scudd., Syst. rev. Amer. butt., 44 (1872).

Euphocaides troilus Hübn., Samml. exot.

schmett., II, Lep. I, Pap. II, Gent. II, Archontes A., herold 4, figs. 1-2 (1820-1821);—Scudd., Psyche, I: 131-132 (1876); Butt., 304, 309, figs. 50, 51, 53, 60, 173 (1881).

Papilio ilioneus Smith-Abb., Lep. ins. Ga., I: 3, 4, pl. 2 (1797);—Abb., Draw. ins. Ga. Brit. Mus., xvi: 20, pl. 77 (ca. 1800);—Feld., Spec. Lep. huc. descr., 27-28, 75 (1864).

Figured also by Glover, Ill. N. A. Lep., pl. 1, fig. 3? 4?; pl. 29, fig. 9 (ined).

I'll tell you them
all by their names as they pass by; but mark
Troilus above the rest.

SHAKESPEARE.—*Troilus and Cressida*.

When bursting forth to life and light,
The offspring of enraptured May,
The Butterfly on pinions bright,
Launch'd in full splendour on the day.

Her slender form, ethereal light,
Her velvet-textured wings infold;
With all the rainbow's colours bright,
And dropt with spots of burnished gold.

The Butterfly's Birthday.

Imago (8: 4, 5). Head black; a small, circular, straw yellow spot, with occasional long, black scales just behind and outside of the base of either antenna; in front, next the eye, but separated from it by a narrow line of black hairs, is a longitudinal, straw yellow spot, extending from the base of the antennae to the tip of the palpi; a yellow spot next the base of the palpi beneath. Antennae uniform black, with a few irregularly scattered white scales. Palpi clothed with yellow hairs exteriorly, with black hairs interiorly, the former forming a band in exact continuation of that above, beside the eye. Tongue uniformly blackish brown throughout, the coil 3 mm. in diameter; papillae (61: 56) very few and distant, appearing as mere hemispherical protuberances on the middle of each maxilla near the tip.

Prothorax black with two small, yellowish spots above, on either side, anteriorly and two similar posterior ones; rest of thorax above black or blackish brown, the patagia black, delicately edged on either side with a slender row of inconspicuous, yellow hairs: beneath, the thorax is warm blackish brown; at the base of each wing is a small, roundish, yellow spot; between the middle and posterior coxae are two somewhat similar but less distinct spots, the lower somewhat linear and obscure, both, with the spot at the base of the fore wings, forming a straight row of equidistant spots; there is a similar series of spots behind the posterior coxae and including the spot at the base of the hind wings. Femora black with a long, triangular spot of yellowish scales at the tip above, its base resting on the tip; tibiae and tarsi dark brownish black, the last tarsal joint a little paler at apex; foliate appendage of fore tibiae dirty pale brownish, darkest above; spurs dull red, black at base; claws dull reddish, weakly curved, very slightly divaricate, long and pointed.

Wings above blackish, lustrous, velvety brown; the apical half of the fore wings not quite so dark in the female, with black nervures; a submarginal row of roundish, pale straw colored spots, their edges obscured by an intermingling of black scales, distant from the margin by half the width of an interspace, occupying the seven lower interspaces, decreasing considerably in size from below upward, the lowermost double and extending nearly across the medio-submedian interspace, the uppermost sometimes no broader than the antennal stalk; a little within this row of spots, below the submedian nervure, is a small, longitudinal patch of pale yellowish green scales, and in the interspace above, a diagonal streak of similar scales; sometimes a very few scattered scales of the same color will be found in each of the median interspaces, forming, with those previously mentioned, a transverse row subparallel to the sub-

marginal row and just outside of the transverse mesial row of spots to be mentioned on the lower surface, and which the translucency of the wing sometimes allows to be seen above; fringe black, interrupted with straw color in the interspaces where the submarginal spots occur, narrowly above, broadly below, doubly on the lowermost. *Hind wings* with a series of six very high, submarginal lunules of a pale yellow green or pale blue green, often profusely sprinkled in the centre with pale straw colored scales, situated in the upper six interspaces, facing downward, the upper also a little outward, their outer edges distant from the margin one-quarter the width of an interspace, excepting the upper ones, which are much further removed from it; there is also a similar lunule in the medio-submedian interspace, but the inner half is bright orange; in the middle of the costo-subcostal interspace is a large, roundish, transverse spot of brilliant orange, edged, excepting outwardly, with a rather broad powdering of whitish or pale bluish scales; the apical half of the wing, nearly to the submarginal lunules and approximately bounded, toward the base, by a line drawn across the wing from the exterior border of the costal orange spot, through the apex of the cell, is either profusely powdered with pale yellow green, or pale blue green scales, most profuse basally, often extending into the cell with a few scattered scales, usually exhibiting a few diagonally transverse, open or partially open spots midway between the basal border of the field and the submarginal lunules, in all excepting the two lower median interspaces; replaced by a small, transverse patch of bright metallic blue scales over the internal submarginal lunule (♂); or, it is the same, excepting that the apical half of the area is composed more or less of bright metallic blue scales, sprinkled broadly along the nervures in the middle of the wing and especially in the second median interspace with pale yellow green scales (♀); fringe black, interrupted in the interspaces, more broadly below than above, with very pale straw yellow.

Beneath blackish brown, the basal two-fifths of the hind wings slightly olivaceous dark slate brown, the apical third of the fore wings, above the median nervures, dark slate brown. *Fore wings* with a submarginal series of pale straw colored spots, the repetition of those of the upper surface; there is also a submarginal transverse row of similarly colored, irregular, triangular spots in the same interspaces, their outer edges only (the bases of the triangles) well defined and following a very slightly curving course nearly at right angles to the lower median nervule at its middle; there is a double transverse spot of the same color in the middle of the apical fourth of the cell and a few very inconspicuous yellowish scales are scattered along the costal border. On the *hind wings* there is a submarginal row of seven transverse, oval, reddish orange spots (occupying the position of the lunules of the upper surface) edged externally, and generally to a less degree internally, with whitish or pale straw yellow scales; there is a subparallel mesial row of similarly colored lunule-like spots, six in number (the middle median interspace being omitted), edged rather broadly above with whitish scales, the uppermost spot very large and occupying the position of the orange spot of the upper surface; the next two much smaller, transverse and approximately semicircular, the fourth longitudinally subpyriform, the fifth roundish and the last variable, the last three of nearly the same size but scarcely more than half as large as the first; in the middle median interspace the position of the spot is occupied by a comet-like brush of bright yellow green scales, composed of two slightly separated branches, reaching as far as the submarginal lunule, and having its nucleus composed of a very few dull whitish scales; it is broadened by a slight pencil of similarly colored scales, emitted from the middle of the adjacent sides of the adjoining spots; occasionally it includes between its branches at the very base a longitudinal orange streak, the remnant of a spot; between these two rows of spots, but separated from both by a belt of velvety black, and broken in the middle median interspace by the two branches of the greenish comet, the whole space is sprinkled with bright metallic blue scales, clustered into distinct, transverse streaks above, becoming less and less frequent posteriorly; fringe as on the upper surface.

Abdomen glossy black; a lateral row of yellow spots, increasing in size posteriorly, at the base of each of the segments but the penultimate, where it is placed at the tip;

beneath, on either side at the outer edge a similar row of seven yellow spots on the tips of the segments, the sixth and seventh continuous, and forming a U-shaped, narrow band, sometimes broken in the middle, from the middle of which runs a delicate median line of yellow scales, toward the thorax, crossing three segments, sometimes broken into minute spots at the incisures. Valves of male abdomen (35: 19, 20) pretty large, regularly oval, a little produced at the tip, tumid; the upper a little more rounded than the lower border; the interior amature consists of a horizontal lamina, thickened at the edge, having a long sweeping curve, especially apically where it is a little recurved and bears at the extremity of its posterior extension and also a little beyond the middle, a backward curving, pretty large, but delicate, depressed spine; the recurved apex bears just above the apical spine a series of six or seven delicate curved spines pointing downward, and increasing in size from above downward. The upper organ consists of a pair of narrow, incurved, strongly compressed and laterally curved forceps-like organs, docked at the tip, and situated on either side of the vent. The hook of the eighth abdominal segment is slender, nearly equal, subquadrate, at first filling the basal space between the valves, curving equally with them, afterwards curving more strongly downward, like a rabbit's tooth, and terminating in a rounded subspatulate tip. This just touches the upper portion of a fleshy protuberance formed of a thick, heavy, tumid base, from which springs a honey-colored finger as long as the base and vertically ovate and compressed at tip with a longitudinal opening. Beneath the upper organ, previously described, springs a fleshy, testaceous, elongated, cylindrical organ, as long as the finger just mentioned, but nearly twice as large on apical as on basal half.

The termination of the female abdomen, as studied in fresh specimens, deserves notice. The terminal segment is much smaller than the penultimate; viewed laterally it is very blunt, truncate; viewed apically, vertically obovate and slightly compressed; from above suddenly and almost equally compressed. The posterior orifice is lined with black hair-scales; when denuded it is seen to be obovate, well rounded, the lower edge imperfect, being brought to a sharp angle and capable at this point of dilation. From this orifice, which is 2.1 mm. long vertically and 1.25 mm. broad, protrudes (not more than .5 mm. when at rest, 1 mm. when forced out by pressure) a pair of large, horny, brownish valves, the ovipositor, slightly fringed with delicate hairs, their edge thickened, each valve not greatly gibbous, parting very slightly in the middle of the lower half to form a slight opening. The lower portion of the penultimate segment is separated from the upper by a division in the middle posteriorly; the lower portion forms a pouch, the vagina, beneath the parts before described; it has a U-shaped form, is incrassated at the sides and retreats slightly in the middle, leaving a space equal to the length of the orifice of the ovipositor. From the upper wall of this pouch hangs a short, cylindrical, fleshy body, and directly beneath it, lodged on the lower wall, is a spatulate blade, the tip of which is naturally exposed to view on denudation; viewed from above it has a truncate, spatulate appearance, the outer corners of its terminal edge produced to short fine points; its upper surface is flat excepting in the middle near the tip where it is sulcate; it appears to be a cylindrical tube open along the lower side and spreading at the tip, but in reality is formed of two appressed pieces, each the extremity of one of the lateral ribbons next to be mentioned. On either side the whole surface is guarded by a most irregular, thin, chitinous ribbon, its surface wavy and tortuous (like the Devil's apron of the seashore, or some thistle-leaves), bristling at every angle with fine points or curving spines; all of these arise from the upper edge and most of them from the posterior half, excepting one on either side arising from the middle of the under surface, rising to the same height as they, and opposed to them and to the corners of the lower spatulate organ; these are compressed thorns, armed with four or five teeth of irregular position and shape; these thorns and the spines arising from the posterior half of the ribbon, form on either side an irregular coronet of bristling spines, which is fully exposed to view only after pairing, when these parts protrude more or less (61: 48), and present a formidable appearance. The nearly unarmed halves of the ribbon pass up on either side of the fleshy

protuberance for its protection and nearly meet behind and above it in two short, raised, opposing edges. The entire length of one of these ribbons if extended would be 2 mm.; of the thorn arising from its lower edge apparently less than .5 mm. The edge of either side of the penultimate segment is produced into a very thin delicate and transparent lamina, prominent, regularly rounded and interiorly concave opposite the coronet of bristles, and although very delicate appears to serve as a guard to them.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Tongue, 17.5 (♀); 24.5 (♂) mm.						
Length of fore wings.....	40.	48.	48.	49.		52.5
antennae.....	13.5	16.5	16.5	15.5		16.5
hind tibiae and tarsi....	12.5	15.25	15.25	16.		15.75
fore tibiae and tarsi....	9.5	11.75	11.75	13.5		11.

Described from 5♂, 2♀.

Variations. Mr. W. D. Denton has shown me a specimen in which other than the uppermost of the extra-mesal row of orange spots of the under surface show upon the upper surface, viz., the spots in the upper subcostal interspace and in the medio-submedian interspace. These are by no means so large nor so pure as below, and still less distinct and much smaller is a long oval orange spot at the base of the second subcostal interspace.

Mr. E. M. Culbert has a specimen in which the normally orange lunule next the costal edge of the upper surface of the hind wings has no orange in it, but is of the same greenish color as the other spots.

Strecker describes a partially suffused specimen, preserved in Peale's collection, having "the submarginal lunules of secondaries prolonged inwardly towards base, forming dashes or rays"; and also a highly interesting aberration as seen in a specimen in his own collection "with, on under surface of hind wings, a narrow yellow band which crosses the wing nearly parallel with abdominal margin, running from near anal angle to costa a short distance from base, the same as is always found in palamedes." (Syn. cat. macrolep., 72.)

Egg (66:13). With an exceedingly delicate tracery, within which the floor is nearly smooth and a little glistening. The cells of the micropyle (68:20) nearly circular, are very minute, not over .004 mm. in diameter, and the micropyllic canals, to the number of about twenty, are clustered into a space not over .02 mm. in diameter; color very pale green when laid; afterwards they become transparent white, and subsequently spots of a darker green appear on the upper surface. Height, 1 mm.; breadth in middle, 1.3 mm.

Caterpillar. *First stage (72:8).* Head (79:69) blackish brown above in two large coalesced oval spots which extend down either side of the frontal triangle half way to the base; rest of head, excepting the hind margin and ocelli which are blackish, pale greenish; labrum and antennae pale; hairs black. Sides of the body either pale plumbeous or dark brownish fuscous; dorsum either pale or variegated with brownish fuscous and yellowish brown, the darker colors being more conspicuous on the first to third and fifth to seventh abdominal segments, and the lighter tints more decided away from the middle; the first thoracic segment brownish fuscous, lateral tubercles of first thoracic segment brownish yellow or pale luteous; the fleshy warts of the supralateral series are luteous on the second, third and eighth abdominal segments, dusky on the others; sometimes all are pale; first segment bears a pair of subdorsal white spots; all the hairs are black, those of the lateral and supralateral rows tipped with white. Legs blackish; prolegs dusky; osmaterla pale orange. In a few days they become entirely mottled with fuscous and yellowish brown, sometimes one and sometimes the other being in excess. Length, 2.6-3.75 mm.; breadth anteriorly, .75 mm.; posteriorly, .5 mm. When full grown the length is 5.5 mm.; breadth of head, .75 mm.; greatest breadth of body, 1.5 mm.; at posterior extremity, .9 mm.

Second stage (72:9). Head (79:70) as in the next stage. Body tumid in the ante-

rior half, broadest at the third thoracic segment, the posterior half nearly equal. Very dark olive brown, the first thoracic segment with a transverse, dull orange spot in the middle of the dorsum, the third thoracic segment with a rather large, lateral, obliquely oval, velvety black spot, bordered above and below with yellow; a lateral white band on the lower portion of the second and third thoracic and first and second abdominal segments, curving upward to the upper portion of the sides on the third and sending a small line backward upon the fourth abdominal segment; eighth abdominal segment white, with two subdorsal yellowish brown spots placed posteriorly; on the first and fourth to sixth abdominal segments a pair of minute, bluish white, subdorsal spots; the first and second thoracic and ninth abdominal segments with a pair of short, thick, cylindrical, fleshy, infuscated, lateral tubercles, furnished with short black hairs, those of the ninth segment much the longest; a similar but not infuscated supra-lateral pair on the eighth abdominal segment; a subdorsal row of small warts on all the segments, but conspicuous only on the eighth abdominal, which also bears a smaller, secondary pair within and in advance of the others. Length, 9 mm.; breadth of head, 1 mm.; greatest breadth of body, 2.5 mm.; posteriorly, 1.75 mm.

Third stage (76:19, 22). Head (79:71) pale greenish with an orange tinge, covered with very delicate, very short hairs; ocelli black in a pale fuscous field; mouth parts pale yellowish. Body above, blackish, sometimes olivaceous brown, mottled with glistering black, below pale bluish green; a straight white band runs from the spiracle of the first thoracic to a large laterodorsal white spot on the third abdominal segment, sometimes interrupted or obscured with blackish brown on the second abdominal segment; the eighth abdominal segment white, with a triangular, dorsal, anterior patch of the color of the rest of the body; tip of body white; on the first and fourth to seventh abdominal segments a laterodorsal row of small, longitudinally oval, pale blue spots; on the third thoracic segment a large, slightly elevated, shining piceous, lateral wart, centrally placed, and in front of it a velvety black spot of equal size, the whole edged with yellow; a subdorsal series of small, shining, yellowish brown warts on the third thoracic and first and second abdominal segments; on the third thoracic a pair of similar ones just above the larger lateral one, and on the first abdominal another similar pair just below the laterodorsal blue spot; first thoracic segment with a pair of lateral warts which are brownish yellow at tip; eighth abdominal segment with a pair of laterodorsal yellowish tubercles and the ninth with a pair of lateral, elongated, brownish yellow tubercles furnished with frequent, short, straight hairs. Osmaterium pale orange. Body covered with very short and very delicate hairs. Legs of the color of under surface, the claws blackish; ventral prolegs pale greenish brown; anal prolegs white. Length, 15 mm.; breadth anteriorly, 4.25 mm.; breadth posteriorly, 2.5 mm.; breadth of head, 1.8 mm.

Fourth stage. Head (79:72) uniform pale green, the ocelli brownish fuscous points, the two anterior darker than the others; mouth parts and other appendages pale green, infuscated toward tip. Body, above, varying from blackish brown to rather pale olivaceous brown, bluish white beneath and on lower edge of sides to just above the stigmatal line. This is slightly whiter above the stigmatal line, forming a white supra-stigmatal band which runs up a little higher on the first thoracic segment, sends a broad, oblique shaft upward and backward to the laterodorsal line on the second and third abdominal segments, and across the eighth abdominal segment except for a small median spot; the supra-stigmatal white band also encircles the tip of the body. The oblique thrust of the supra-stigmatal band is to give effect to the great hunch of the anterior part of the body when at rest, as it partly encircles its posterior margin. The dark upper part of the body is, however, much enlivened by other markings: generally the fourth and fifth abdominal segments and especially the dorsal parts within the laterodorsal lines, sometimes the whole of the abdominal region behind the hunch is of a slightly lighter tone than the rest; the same is sometimes the case with the top of the hunch, especially laterally within the velvety patch; and the whole of the dorsum of the first and second thoracic segments behind the anterior, pale orange, osmaterial ridge is always as dark as any other part and generally is rather darker. Besides

these variations in tone there are the same markings that are described for the previous stage, the piceous and velvety patches, the longitudinally oval, turquoise spots, the glistening warts, etc., and they do not differ in any marked respect. Length, 25 mm.; breadth of head, 2.65 mm.; of first thoracic segment, 3.5 mm.; of third thoracic segment, 6.5 mm.; of eighth thoracic segment, 4 mm.

In specimens which are of the pale olivaceous type, the markings differ slightly, for there is a pair of large, oval, yellowish brown spots on either side of the dorsal line of the first abdominal segment, truncate posteriorly by the segmental line, and having the turquoise spot of this segment near their middle. Accompanying this the black patch is very much more broadly bordered with this same yellowish brown above, coming half way to its appearance in the next stage, and in very marked distinction from the appearance of the other individuals of the same stage.

Last stage (76: 18). Head (79: 73) pale green; antennae pale, ocelli pale or darker yellowish brown or slightly fuscous. Mouth parts pale, excepting a spot at the base of the mandibles and the extreme edge of the same, which are reddish. Body above darker rich green, of the color of the sassafras leaf on the thoracic segments, a little paler on the abdominal segments, from being more or less flecked with obscure, paler spots, scarcely visible to the unaided eye. A wavy, slightly irregular, black stigmatal line extends from the apices of the osmateral orifice to the middle of the last abdominal segment. Just above this is a pale, clear yellow band, which also borders the osmateral orifice posteriorly, where it is brighter and is followed by a transverse, piceous patch, traversed by a delicate dorsal line, the hinder border of the patch being straight and the front border convex. On either side of the third thoracic segment is a large, nearly circular, pale buff, supralateral spot, extending nearly across the segment, bordered with a fine black line, and having within it, in the lower posterior corner, a large reniform, velvety black patch, in the lower posterior corner of which patch again is a piceous, rounded wart; anteriorly the spot has a transverse, bent, narrow black streak, sometimes joined to the patch; and above, a small, longitudinal, ovoid, turquoise spot, narrowly edged with black; on the first abdominal segment is a pair of circular, buff colored, laterodorsal spots, a little more than half as large as those of the preceding segment, edged with black and having within them anteriorly a small, longitudinal, ovoid, turquoise spot edged with black. There is a laterodorsal series of small, ovoid, turquoise spots, edged with black, on the second to eighth abdominal segments, quite small on the second, third and eighth segments, and largest on the fifth and sixth; a similar lateral row on the second to seventh abdominal segments, and an infrastigmatal series of similar but nearly equal triangular spots on the second to eighth abdominal segments. Beneath pale green, tinged with dull brownish roseate, especially on the abdominal segments. Osmaterium lemon yellow. Spiracles pale green, edged very narrowly with black. Legs and prolegs of the color of the under surface. Length, 27.5 mm.; breadth of head, 4 mm.; of body, at third thoracic segment, 8 mm.; at third abdominal segment, 5.75 mm.; at seventh abdominal segment, 4.25 mm.; at eighth abdominal segment, 5 mm.

Other specimens measured 38 mm. long and 10 mm. broad. After evisceration, the caterpillar, besides shrinking greatly in size, turns of a yellow color, although occasionally the change of color takes place previous to the evacuation of the contents of the intestinal canal.

Chrysalis (85: 5-7; 87: 6, 15). The whole dorsal surface either pale yellowish green, becoming yellow toward the middle, and with a reddish brown dorsal line, obsolete on the head and posterior half of the mesonotum; or, griseous with mingled yellowish and reddish brown dottings, paler next the middle, and with a dusky dorsal line, interrupted as above. Whole ventral surface either delicate pale grass green, the legs spotted a little with black and rusty brown; or, grayish brown, darkest on the appendages, marked with delicate, dull yellowish lines. The ocellar prominences (86: 34, 35) are always brownish fuscous, and the dorsal carina bordered with reddish brown or brownish fuscous, and itself crested with a paler color. There is a laterodorsal row of minute whitish spots, ringed with blackish brown, extending from the

metathorax to the eighth abdominal segment, a little largest on the fourth and fifth segments; a lateral row of similar spots on the same segments, midway between the previous row and the stigmatal carina, that on the metanotum large and obscure, those of the first and eighth abdominal segments often obsolete. Length, 30.5 mm.; breadth at ocellar prominences, 7 mm.; at basal wing tubercle, 7.5 mm.; at third abdominal segment, 8.75 mm.; height at mesonotal tubercle, 8.25 mm.; at second abdominal segment, 9.25 mm.; distance from tip of ocellar prominences to mesonotal tubercle, 9.75 mm.; length of mass of hooklets longitudinally, .68 mm., breadth of same transversely, .8 mm.; length of hooklets, .2 mm.; width of their apical cup, .05 mm. There is no sexual distinction whatever in the chrysalis, either in color or in the form of the terminal abdominal segment.

Malformations. Mr. Roland Thaxter brought me, September 27th, 1875, a living chrysalis of this species, with the head of the caterpillar still remaining upon it (86: 74-80). The head is split, as ordinarily when cast for the last time, and the two hemispheres hug the base of the right ocellar prominence of the chrysalis, the left ocellar prominence being greatly aborted and entering the heart of the left cephalic hemisphere; the right hemisphere is nothing but a pellicle, connected only with the opposite half, but the left seems to be closely soldered to the insect, although the edges are free almost or quite throughout; in addition, the pellicle and hardened dorsal shield of the first segment of the larva are present, directly behind the left hemisphere; the frontal triangle and all the mouth parts of the larval head remain naturally attached to the left hemisphere; there is nothing else peculiar to the creature excepting its total lack of maxillary and antennal cases, the empty trough for the reception of the former being particularly conspicuous, while that of the latter is closed on the distal half, or, on the right side, even more than that. This makes it all the more probable that the larval head has still an organic connection with the insect. The chrysalis was raised from a caterpillar found in the open air, just ready to change. That it may not be uncommon is shown by the fact that Mr. Thaxter once had four such chrysalids which were unfortunately eaten up by mice.

Prof. E. L. Mark also once wrote me that he had raised a malformed pupa in which the tongue and antennae were raised from and projected in a line with the body, extending in front of the head; a parasite emerged from it.

Dr. C. V. Riley also obtained from rearing *Iphiclidides ajax* a monstrous chrysalis with the larval head still attached.

Geographical distribution (27: 1). Excepting in New England the distribution of this butterfly is almost precisely the same as that of *Iphiclidides ajax*. It ranges over nearly the whole extent of both the Alleghanian and Carolinian faunas, from the Atlantic coast to the barren plains west of the Mississippi. Southward it occurs abundantly almost, if not quite to the extremity of Florida, although in Apalachicola it is "rare and accidental" (Chapman); it is also abundant in Alabama (Gosse), has been taken at the mouth of the Mississippi (Riley), and is said to occur in Texas (Strecker). Westward it is found as far as Vicksburg, Miss. (Mich. Univ. Mus.), Missouri (Riley, Stolley, Mus. comp. zool.), eastern Kansas, "very rare" (Snow) and Iowa,—Ames (Osborn), Davenport (Putnam). Its extreme northern limits, at least east of Lake Michigan, seem to be marked by the annual isotherm of 45°; immediately west of this we know nothing of it except to the southward, where it apparently extends to the borders of the Great Plains; but that it must occur also in the northwest seems evident from its capture by Geddes at Fort McLeod

in the Rocky Mountains north of our boundary, as far from its nearest known neighbors as they from their distant Florida friends! The northern limits are approximately marked by the following localities: Racine, Wis., "not rare" (Hoy); Chicago, Ill. (Riley); southern Michigan, "not common" (Mus. Univ. Mich. and Harrington), Cleveland, Ohio, "common" (Kirkpatrick); Ontario, "not uncommon throughout the western and southern portions" (Saunders); Essex Co., Dunnville, (Lowe), and St. Catharines, Ont. (D'Urban). Further east it fails in Canada, but it occurs through all but the northern parts of New York, being rare at Schoharie, but rather common in Albany Co. (Lintner).

In New England its distribution accords perfectly with the foregoing, for it is not an uncommon species in the three southern states, even in Berkshire Co., Mass., and has been found north of Massachusetts as follows: in New Hampshire at Milford (Whitney), Dublin (Faxon), Suncook, "pretty common" (Thaxter) and Walpole (Smith); and in Vermont at Sudbury, scarce (Scudder).

Haunts. This butterfly is usually found in the vicinity of woods and groves and, in the latter, particularly in damp open woods and about marshy thickets. In the south, according to Doubleday, it is often seen flying in company with *L. philenor* "on flowers of *Cephalanthus occidentalis*, *Anona grandiflora*, etc., and on the muddy roads." In the north, the first brood seeks the blossoms of the lilac and of the laurel.

Oviposition. The eggs are laid singly on the under surface of the leaves far from the edge and on the apical half of the leaf; the leaves generally chosen appear to be such as are near the tip of a shoot, yet not the apical ones, and small trees or bushes are preferred. Miss C. Guild, who has discovered a large number of the eggs of this species, tells me that they are always found upon the under side of leaves, at least she has seen but a single exception; she also states that they occur most abundantly on small sassafras bushes, only one on a plant. Dr. Riley has also always found them on the under side. On the other hand, Dr. Wittfeld, in Florida, says they are deposited on the tips of the upper surface of the red bay. Their period has not been determined, excepting in Florida where Mr. Wittfeld found that they hatched in four days; in the north it is certainly longer than that.

Food plants. Lauraceae form the ordinary food of this caterpillar; the spice bush, *Benzoin odoriferum* Nees, is most commonly chosen, then the sassafras, *Sassafras officinale* Nees. It has also been found occasionally on plants of other great divisions, some far removed from these. Thus Wittfeld says that in Florida it feeds upon the red bay, *Magnolia glauca*, one of the Magnoliaceae, Mr. Riley tells me that William Muir has found it on the prickly ash, *Xanthoxylum americanum*, one of the Rutaceae. According to Mr. Lintner it has been found on wild cherry,

Prunus serotina Ehrhart, and Mr. Riley has taken it on the peach, *Prunus persica*, and the choke cherry, *Pirus arbutifolia*, in Missouri, all Rosaceae. Besides these polypetalous plants it has been found in one or two instances upon gamopetalous plants such as the lilac, *Syringa vulgaris*, one of the Oleaceae, and also in a single instance by Mr. Riley on sweet potato, *Ipomoea batatas*, one of the Convolvulaceae, but he himself doubts whether it feeds upon that plant. The most remarkable of all, however, is, according to Riley, its capture by Mr. Monell in Missouri upon *Juniperus sabiniana*, a coniferous tree.

Habits and habitation of the caterpillar. When it first comes from the egg the young larva, after devouring its egg shell, bits a channel down one side of the leaf on which it was born, about a centimetre or a centimetre and a half from the tip, straight or a little obliquely to the midrib, then folds over the flap thus obtained upon the upper surface of the opposite side and lives in the depth of the concealment thus formed (82:5); no silken threads fasten the edges together,* yet the edge of the flap is pressed firmly upon the opposite side, solely by the repeated crossings next the midrib of transverse strands of silk, so as to form a dense, glistening, whitish carpet covering a width of about seven millimetres, but thickest in the middle and extending the whole length of the enclosure made. If forced open by hand, the flap at once regains its former position when freed, showing the tenseness of the silken strain. The deepest part of the nest is somewhat cylindrical, so that an opening of about three millimetres in diameter is found at the end away from the tip of the leaf, through which the larva finds ample room to creep even after it has passed its first moult, which it does in this chamber. I have found them in such a nest even up to the beginning of the third stage. It is by no means rare to find such nests with the leaf cut in a channel down to the midrib on both sides, as if it had been difficult, with one channel only, to draw the two sides of the leaf together. It feeds upon the same leaf, gnawing great holes out of the sides of the leaf, but before this is nearly consumed it passes to a new leaf to renew its operations. Being now larger and stronger it makes its nest in a different way, without first preparing a flap. By the same method of weaving the silken floor of its proposed abode, and by forming its track far to one side of the middle of one half of the leaf, it folds over upon itself one side of the leaf so as to make the edge fall upon the upper surface of the leaf upon the same side of the midrib, and generally, though not always, on the apical rather than the basal portion of the leaf, and so constructs a long and rather narrow, flattened cylinder, in which the edge of the leaf is in every part closely appressed to the surface, and out of which it can crawl at either end. From this retreat it passes at will to feed upon the

* Edwards says (Can. ent., xvi: 115) that "stitching it closely," but this is certainly a mistake.

neighboring leaves, very rarely upon that it has selected for its abode. When this has become too strait for its rapidly growing body, it forms another of similar nature but of larger size, the edge falling upon or beyond the midrib (82: 4); and finally, in its last stage or even earlier, it takes up its position upon the very midrib and by the same process causes the opposite edges of the leaf to exactly or almost exactly meet above its back, leaving only a passage out, and often a very confined one, next the leaf stalk (82: 6). Thus it passes its entire larval life, when not feeding or preparing its abode, in entire concealment, undergoing all its ecdyses within the cleanly home, where it drops no excrement and suffers none of its cast off clothing to remain, eating up its cast off skin and hustling its no-longer-needed skull-cap out upon the ground.

The ordinary movements of the full grown larva when exposed to view have an absurdly affected look. It moves or seems to glide by little starts about a second apart, in a very slow and measured way. It is evidently no necessity of its organization, but a superinduced habit for some protective purpose, probably in correlation with its great thoracic spots and hunch. Probably this panting spasmodic approach of so singular looking an object may be a source of fright, possibly of curiosity, to some of its natural enemies, sufficient to protect it until it again gains cover.

Owing to its "musky" odor, Abbot says this caterpillar has gained in the south the name of "mellow bug"; yet it seems to be less inclined to use its osmateria than our other Papilioninae, and when provoked to do so generally ejects them but partially, even when full grown; in the first stage it cannot with the roughest handling be induced to use them.

The color of the caterpillar is exactly that of the leaf on which it rests. One or two days before changing to chrysalis the caterpillar, like others of the group, ejects the entire contents of the alimentary canal, reducing the animal very materially in size; shortly afterward its color undergoes a decided alteration, the green changing to yellow*, closely resembling, as Miss Guild pointed out to me, the appearance of the sassafras leaf after a frost. So, too, the color of the chrysalis is usually that of the dead sassafras leaf.

Pupation. Mr. C. V. Riley sends me the following account of the caterpillar's preparation for its change:—

After attaching the anal prolegs it forms its loop, not, as is generally supposed, by turning the head entirely back with the mouth parts opposing the object attached to, but by carrying the silk between the first and second pair of thoracic legs. With the prolegs fastened firmly to the vertical side of my cage, the whole operation was performed with the five anterior segments of the body. After attaching one end of the future loop it stretched back as far as those five segments would allow, they being horizontal or at right angles with the other seven. In this position the head is bent

* The spots, however, remarks Riley, change to a slate color, excepting the eye-like spot which remains black to the end of its life.

sharply forward so that the spinneret reaches beyond the first pair of thoracic legs, and the silk is held in the suture made by the first and second pair of legs, the latter pair being swollen and stiff. After attaching the other end of the loop it continues to move backwards and forwards until the loop is of sufficient strength. The thread must be kept taut the whole time and the most difficult part of the feat seems to be this stretching of the thread. Commencing, say, at the left side: after fastening the thread securely it stretches straight out for about half an inch quickly (see *a*); it then usually comes back with an undulating motion of the head, as though to bind the thread; it then pulls out again and commences gradually to get towards the right, the head moving up and down the whole time. The distance *b* occupies more time than *a* and *c* together.



When the head is at the left fastening, the segments are swollen sidewise as at *d* and vice versa as at *e*. After the loop is made strong enough the head is simply slipped under it and the loop is then gradually worked between the second and third abdominal segments.

The chrysalis state lasts about a fortnight or more in summer; in Florida Mr. Wittfeld found the period thirteen days; Abbot, in Georgia, fourteen days.

About twelve or fifteen hours before emerging from the chrysalis, the change in the colors of the butterfly may be clearly seen through the diaphanous tegument of the chrysalis; two or three hours before eclosion the chrysalis looks as though soaked internally with some fluid, and not only are the spots of the wings very evident but one may see that the ocellar prominences and the last segment of the body are empty; occasionally the chrysalis sways itself tremulously with a scarcely perceptible movement; at the last the integument of the chrysalis has a dried and wrinkled look. The butterfly generally emerges early in the day, and the first signs of the immediate change are strong backward and forward movements of the chrysalis at intervals of a few seconds; perhaps the third or fourth attempt will be successful, when a click—the parting of the dorsal thoracic tubercle—may be heard at the distance of several feet; but all the subsequent movements are absolutely noiseless, though rapid; at intervals of three or four seconds movements similar to the first carry on the process; first the split continues along the middle of the pro- and meso-thorax; then it runs down either side between the legs and wings (ultimately to the tips of the antennae) and between the meso- and meta-thorax as far as the silken girt; as this progresses the actions become more strenuous and more frequently repeated; with eager efforts the butterfly pushes forward its half-detached head; now an antenna springs from its case, at once assuming its natural attitude; the other soon follows and then the wings are partially drawn from their sheaths, and while in this position seem to be used as levers or arms to aid in withdrawing the rest of the body; next the legs appear, seize the upper part of the chrysalis skin and speedily withdraw the whole body. It is now a curious looking object, the wings, especially the upper ones, are

wrinkled and bloated, and although the whole process of escape lasts little more than half a minute, are already twice the size of the sheaths they lately occupied; the under side of the first abdominal segment is swollen with the fluids which are destined to force the expansion of the wings, for by the time these have assumed their natural size the segment is no longer inflated. The insect crawls upward until it finds a secure resting place and there remains until ready for flight; each half of the tongue, drawn independently from its receptacle, is rolled in a separate spiral, and now while the wings are gradually expanding the insect applies all its energies to uniting their two parts, incessantly rolls and unrolls them, and beginning simultaneously at the base, gradually fits them together; in about fifteen minutes all but the tips are perfectly united; these require nearly fifteen minutes more, and are not fairly interlocked until the wings are fully expanded, nearly a full half hour after the escape from the chrysalis. The wings, however, are still tender and generally require two hours to stiffen. When at last the insect ventures upon flight it is not with an uncertain flutter, but boldly and steadily, as if long accustomed to the action. But first a fluid is dropped, as in all butterflies, from the hinder end of the body, which in the male is pellucid but in the female straw-colored and granular.

Life history. The insect is double brooded throughout its range and passes the winter in the chrysalis state. The earliest butterflies appear in the south in the first half of March, in the north in the latter half of May; the female appears a week later than the male and butterflies continue to emerge from the chrysalis all through June and are seen far into July. The eggs are laid early in June, the caterpillar passes about a week in each stage (a month for all in Florida) and changes to chrysalis by the middle of July at the earliest, or in the south in the latter part of June; it continues a fortnight or more in this condition and a second brood of butterflies appears, in the south in July, in the north seldom before the middle of August, but sometimes at the very end of July; it becomes abundant in the latter part of August; the full grown larva of this brood may be found from the first week of September or even earlier until the middle of October, when it changes to chrysalis and thus hibernates.

Flight, postures and habits. Its flight is easy and graceful, generally only a few feet above the ground as it courses rather swiftly above the bushes, dropping constantly here and there and pausing in its onward flight to examine every little nook for the flower or plant it seeks; rarely alighting, it seems never weary and passes back and forth in long zigzags across a field with constant revisitations of the same spots.

Speaking of both this species and *glaucus*, De Garmo says:—"When rudely disturbed by a stroke of the net [they] rise high in the air, and immediately seek another resting place, even when on their choicest feeding grounds" (Trans. Vass. br. inst., ii: 130).

Riley tells me that he once heard complaint of this butterfly in Illinois from ladies who charged it with destroying their Verbenas. "They get their tongue into the flower, and in retiring pull away flower and all, thus marring and destroying them."

Mr. Henry Edwards has observed this butterfly at the electric light.

When at rest, the antennae diverge at an angle of about 65° , but the clubs are parallel and the stalks also are parallel at their very base; viewed from the side the antennae curve very slightly throughout the whole length of the stalk, the general direction being forward; the club is gracefully but strongly curved upward at nearly right angles. When at complete rest, the fore legs—at least those of the male—are bent and appressed to the body, the tarsi being pendant and the claws nearly touching the ground.

Mr. W. H. Edwards exposed a chrysalis of this butterfly to extreme cold for fifteen days, but it gave the butterfly "unchanged."

Enemies. Walking one day through a shadowed road where a single example of this butterfly was coursing back and forth, turning always as it met me, I noticed after a short time that it did not return after one of its periodic excursions; and soon the reason was evident, for I came to its four uninjured wings lying in the damp rut; a bird had snatched it as it passed, bitten off the uneatable wings, and devoured the body.

The caterpillar is attacked by *Trogus exesorius* (88:3), an Ichneumon which attacks nearly all the Papilioninae described in this work, stinging the caterpillar; the grub changes to pupa after the caterpillar has become a chrysalis and the perfect insect eats its way out of a circular hole with a ragged edge in the side of the chrysalis in the middle of one of the wing cases, varying from 4.5 to 5.5 mm. in diameter. It hibernates within the chrysalis case and emerges in this species toward the end of May or early in June according to Dr. T. W. Harris. Mr. Riley has also bred a *Cryptus* from the chrysalis (but the specimens cannot now be found) together with a new species of *Apanteles*, *A. emarginatus*. No dipterous parasite is known.

Desiderata. A more detailed and careful account of the seasons of this butterfly in different regions is the principal point needed to complete its natural history. The duration of the egg in the north and a fuller account of the habits of the caterpillar are other desiderata, together with the determination of the unknown parasite mentioned. Do the summer chrysalids ever pass over to the next year? Are there three broods of this insect anywhere in the south? it would seem as if there must be, but our data are very meagre. Our knowledge of its western distribution leaves much to be desired.

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21. Whole eye, enlarged.

HERACLIDES HÜBNER.

- Heracildes Hübn., Verz. bek. schmett., 83 Thoms Swains., Zool. Ill., 121 (1832-33).
(1816). Papilio (pars) Auctorum.

Type.—*Papilio thoas* Linn.

Proles arbuti, Papilio ut forem,
Viola, et lilia, et rosas halans;
Erraticus usque de flore ad florem,
Quae pulchra, quae suavia sunt, osculans!
Non opum sentirem, non regni furorem,
Ut sterneret coram me nemo, curans:
Modò proles arbuti Papilio si forem,
Quae suavia, pulchraque sunt, osculans!
O, nòssem caducum, Magae subtrahere,
Has alulas pulchras induerem mi:
Aestivo sub axe vagantur in aëre,
Et rosâ cubant, ubi gemis, Atthi!
Sit vigil et cautus, qui dives, necesse est;
Nil afferunt sceptrâ, miserias nil:
Papilionem me ter satis esse est.
Rosâ cubantem, cum gemis, Atthi!
Quid quòd autumnû cum redit tempestas,
Vanescunt erronei hi mox parvuli:
Multo plus praestat, cum finit aestas,
Morientibus omnibus pulchris, mori!
In hieme vitae, quæ ridet hic status,
Arcento, si poterunt, letum leti:
Finit Papilio, deganque paratus,
Morientibus omnibus pulchris, mori!

Papilio. (London Times.)

Imago (57: 8). Head pretty large, clothed with short, erect hairs, nearly uniform throughout but a little highest down the middle; front gently tumid, a little protuberant down the middle below and here only as far advanced as the eyes, between the antennae and the tongue rather higher than broad, scarcely so broad as one of the eyes; with pronounced lateral carinae, from the presence, close beside the borders, of a shallow but distinct sulcation; above somewhat depressed but still, though but slightly, convex, considerably lower than the eyes; upper border projecting rather narrowly between the antennal pits but with an even surface, broken only by the delicate raised lip which surrounds the antennal pits; vertex gently tumid, crossed by a pair of faint sulcations converging at the middle of the posterior border, running from the outer

edge of the antennal pits. Eyes very large, very full, naked. Antennae inserted with the anterior edge in the middle of the summit, separated at the base by the width of the second joint, fully as long as the abdomen, with a gentle arcuate curve resulting from a considerable bend near the base and the upward trend of the club; composed of about thirty-eight joints, cylindrical but expanding slightly both at the proximal and distal ends, but especially at the latter, and particularly as the club is approached, which is formed of about ten or eleven joints, its limits ill defined, the joints increasing in thickness and decreasing in length very gradually; it is compressed, triquetral, the broadest face external, gradually increases in size over four or five joints, is then uniform over several joints which are rather broader than long, until the antepenultimate is reached when it begins rather more rapidly to decrease, terminating suddenly with a completely triangular, greatly diminished, apical joint; by the upward trend of the club the lower outer margins of the joints (which over the club are not enlarged at the base) project angularly, giving the lower margin of this part of the antennae a serrated edge; the whole club is about seven times as long as its greatest breadth, and more than twice as broad as the stalk. Palpi minute, moderately stout, not reaching the middle of the front of the eye, heavily beset with scales and fringed below on the inner side with scanty long hairs; the basal and middle joints about equal, the last minute, barely half as long as the middle joint.

Prothoracic lobes obsolete. Patagia of moderate size, the posterior lobe long, tapering, falciform, a little twisted, bluntly rounded at tip, fully five times as long as broad; the inferior lobe short, stout, triangular, the tip bluntly rounded, not much longer than broad.

Fore wings (41:4) twice as long as broad, the costal margin rather strongly convex, curved more strongly for a short distance just next the base, and again, to a greater degree, in the apical half of the region beyond the cell; outer margin very broadly sinuous, being fullest next the lowest submedian nervule, and most emarginate next the upper median nervule; its general direction is at an angle of about twenty-five degrees with a line running through the middle of the cell, and the apical angle is abruptly and the inner angle very broadly rounded; the inner margin regularly and gently sinuous. The first superior branch of the subcostal nervure arises in the middle of the third quarter of the cell, the second at scarcely less than one-half way between this and the apex of the cell; the third at the apex itself; and the fourth at a little less distance beyond the third than it is beyond the base of the second; cell considerably more than one-half as long as the wing, and three and a half times longer than broad; at the origin of its fourth branch the median nervure is raised above where it would be were it in direct continuation of the basal half of the nervure, by nearly the length of the cross vein uniting it to the subcostal; the cross vein uniting the median and submedian near the base very delicate, directed downward at right angles to the median, and curved slightly outward on its approach to the submedian.

Hind wings with the costal margin strongly shouldered at the base, the angle well rounded, beyond gently arcuate to the tip of the costal nervure, where, except for the gentle crenulation of the upper end of the outer margin, it melts into it; outer margin considerably crenulated, somewhat abruptly angulated at the nervule tips, produced in the median region, its general curve, apart from the tail, pretty convex, the two portions of the subcosto-median region separated by the tail, being inclined to each other at angle of about 135° ; the upper median nervule bears at its tip a long and stout spatulate tail, nearly half as broad again near the extremity as at the neck, and about three times as long as broad; the inner margin is gently concave, very narrowly and pretty strongly reflexed, a little expanded near the tip of the submedian, the anal angle with a deep excision reaching half way across the medio-submedian interspace by which, from this interspace, a piece nearly as large as half the tail is removed. Subcostal nervure straight between the bases of the first two nervules or scarcely bent just beyond the middle; vein closing the cell of the same length as that uniting the bases of the second and third median nervules, and a little more than half as long as that uniting the second and third subcostal nervules.

Fore femora as long as (♀) or somewhat shorter than (♂) the fore tarsi; the tibiae scarcely (♂) or fully (♀) three-fourths the length of the femora; middle femora a trifle shorter (♂) or a trifle longer (♀) than the middle tarsi; the tibiae as long as (♀) or a little shorter than (♂) they; the hind tibiae and tarsi of equal length and considerably longer than the femora (♂), or the tarsi, tibiae and femora are successively smaller to a considerable degree (♀); middle and hind tarsi of about equal length and fully a fourth longer than the fore tarsi. Femora scaled only; tibiae armed on all sides with rather infrequent, small, slender, nearly recumbent spines, nearly all of which, and especially those at the lower outer margin, may be assigned to definite longitudinal rows, of which, besides those upon the lower surface, there are five or six series, the inner surface only being free. First joint of the tarsi fully equalling all the rest together, the remainder subequal, the second being longest and the fourth shortest; joints armed on either side beneath with a double row of closely crowded, not very long, slender, subrecumbent spines; both the inner and outer sides narrowly channelled and smooth, but the whole upper surface and upper angle of the sides bristling with minute spines, like those upon the tibiae, arranged for the most part in four or five rows, of which the two outer are more distinctly ranged and have stouter spines. Claws long and moderately slender, compressed slightly, and rather coarsely heeled beneath at the very base; beyond the under edge straight as far as the curved and delicate pointed apex; paronychial and pulvilli wanting.

Second abdominal segment of the male no longer than the first; beyond, the segments decrease slightly and somewhat regularly in length, the middle of the dorsum of the eighth segment developing a spine nearly as long as itself, narrowly triangular, roundly truncate at tip as seen from above, obliquely truncate as seen from below, and not at all curved downward. Valves triangular, with well rounded angles, the narrowest angle below anteriorly, the broadest portion, viewed longitudinally, at the upper base, of equal length and breadth, armed within by an inferior, arcuate, toothed lamina.

Egg. Subglobular, about a fifth broader than high, well rounded, with no depression at summit, the base broadly and roundly truncate, scarcely so broad as the height. Surface uniformly roughened by the secretion of the mother.

Caterpillar at birth. Head large, subquadrate, broader than high, as broad as the body of the first thoracic segment, well rounded, smooth, covered sparsely with bristly, tapering hairs of equal length (more in number than represented on our plate); the triangle more than half as high as the head. Body subquadrate, tapering distinctly from in front backward on the anterior, scarcely at all on the posterior half, slightly moniliform; the first thoracic segment, independent of its tubercles, somewhat larger than the others, all furnished with several series of very large, mammiform, fleshy prominences, hemispherical in front, conical behind, each studded with papillae bearing pretty long, minutely clubbed or rather apically flaring, straight, tapering bristles, and arranged in definite order; viz.: a supralateral series on each of the segments, generally central, becoming posterior on the first thoracic segment; these decrease slightly in size from in front backward, but again increase on the posterior segments to a size rather larger than at first, and here are twice as high as broad; a suprastigmatal series on all the segments, with numerous bristles, in front considerably larger than the first series, particularly those of the first thoracic segment, which, laterally expanding, blunt and stout, nearly double the width of the segment, and are nearly as broad as its length. There is, besides, a subdorsal series of single similar hairs on slight papillae, centrally placed on all the segments, more widely separated on the first thoracic segments; and an infrastigmatal series crowded again with bristles. From specimens mounted in glycerine.

Mature caterpillar. Head of moderate size, appressed, globular, somewhat broader than high, subtruncate and very broadly rounded below, well arched above, distinctly notched between the hemispheres, the face nearly flat. Inner triangle scarcely higher than broad, frontal suture rather deeply impressed; surface smooth and glistening with very sparsely scattered, short, downcurved hairs. Ocelli six in number, five in a

very close, subcircular cluster, of which the two upper front ones are attingent, the others separated by their own width, the sixth below and behind the others, above the base of the antennae. Third joint of antennae cylindrical, more than three times as long as broad.

Body large and corpulent, choerocampoid, being inflated above in front in a single mass, which includes the second and third thoracic and first and the front part of the second abdominal segments, affecting equally the dorsal and lateral outlines of the body but not the inferior; beyond these segments the body is cylindrical, submoniliform, the fifth abdominal segment obscurely hunched. Just outside and behind the osmaterial cleft the first thoracic segment is squarely angled, the only remaining sign of the prominent fleshy tubercles of the juvenile caterpillar. Behind this are found, dorsally, series of lenticles, distinct, usually hemispherical, and always glistening in the penultimate stage, scarcely elevated and wholly dull in the last stage, situated as follows: on the second thoracic segment a transverse, median, straight series of six equidistant lenticles, growing larger outwardly; on the third thoracic and first abdominal segments a sinuate series of six on the anterior half of the segments, the curve opening posteriorly, equal and equidistant on the third thoracic segment excepting that the middle pair are approximated, unequal and inequidistant on the first abdominal segment, the outermost being more distant and smaller than the others, situated just above the spiracle. Behind these somewhat irregular and generally larger ones, there is on the abdominal segments a laterodorsal anterior series of much smaller ones on the second, third and fifth to seventh segments, and a supralateral central series on the second, fifth and sixth segments, larger than the last. Many of these are with difficulty seen in the mature caterpillar. The spiracles are ranged along a line scarcely below the middle of the sides.

Chrysalis. As seen from a side view fusiform, the dorsal line except for the mesonotal elevation nearly straight, the ventral bent at the swollen and rounded middle at an angle of about 135° , the mesonotal elevation considerable and abrupt, its front perpendicular to the general dorsal line, behind it falling off to the abdomen with a scarcely arched slope; separation of the thorax and abdomen faint. Viewed from above appearing as if formed of three masses, the anterior two quadrate, the posterior fusiform; the first is made up of the head and prothorax, with the forward reaching, ear-like ocellar prominences; the second of the abruptly expanded thoracic mass, more than half as broad again as the part in front, anteriorly rectangular, scarcely narrowing behind; the fusiform third part of the abdomen, broadest at the hinder end of the third segment, in front and behind which it slopes about equally. Front of head flat, together with the same face of the ocellar prominences, which are bent from the front at an excessively large angle; the prominences triquetral, as long as the prothorax one face outward, the arched superior ridge roundly and rather deeply emarginate at the base, the inferior ridge gently arcuate, the interior thrice stepped, the middle step twice the length of the others. Mesonotal tubercle triquetral, stout, the superior face more or less hollowed, the ridges corrugated. Basal wing tubercle low, broad and irregularly triquetral, the small supernumerary tubercle at the lower end of its posterior ridge. Body a little pinched at the upper posterior angle of the wing-cases; a laterodorsal series of small granulate tubercles just behind the middle of the abdominal segments; surface scabrous and punctate. Cremaster tetraquetral, twice as broad below as above, all the sides hollowed but especially and broadly above and below, apically truncate, the field of hooklets transverse, the hooklets thickly crowded, rather long, not very slender, apically expanding laterally, recurved and apparently chisel edged.

This genus is composed of half a dozen species or more, confined to the American continent but ranging therein over mainland and island to ten degrees at least on either side of the tropics, and on both sides of the Cor-

dilleras. Only one species is at all common in the United States, but a second is recorded from the southern borders and others are found in the neighboring parts of the Antilles and mainland. The single indigenous species has a wide range and has of late years extended its domain far to the north and even invaded New England.

The butterflies are above the average size of swallow-tails and of a striking appearance from their contrasted colors, which are fully displayed in their somewhat majestic and dignified flight, wherein the deep black ground of the upper surface, and the saffron hue of the under surface of the wings are alternately brought into view. The upper surface is also crossed by two very bold, broad bands or subcontinuous series of large spots of bright yellow, which adds to the conspicuous appearance of the butterfly, and all the species have large spatulate tails.

The insects are polygoneutic, being double brooded at their northern confines, and they apparently winter as chrysalids,—perhaps also as butterflies in the hotter regions. The eggs are laid singly and hatch in a week, more or less. The caterpillar stages are passed in from twenty to forty days according to circumstances, and the chrysalis hangs for rarely less than a week, generally a fortnight, but may be much longer continued, showing a tendency, perhaps induced from sometimes wintering, to greatly prolonged life. The caterpillars live in earliest life upon the under side, but afterwards fully exposed, upon various trees, but apparently mostly upon Piperaceae in the warmer, Rutaceae in the cooler regions, and especially upon oranges.

The metamorphoses of several of the species are known, principally through studies in the cooler parts of the district inhabited by the species of the genus in the two Americas. The eggs are almost exactly spherical but for a considerable truncation at the base and are smeared with a thin coating which obscures the surface, but by no means to the same extent as in *Laertias*. The young caterpillars are armed with exceptionally large and coarse tubercles beset with numerous divergent clubbed hairs, so as to give the creature an unusually formidable aspect; especially are the lateral outgrowths of the first thoracic segment very large, exceeding in importance those of *Euphocades*, which genus the present most resembles at this stage; at this very beginning of its life the same colorational contrasts between the different parts of the body are found, though not in the same detail, as afterwards obtain, the central and posterior parts of the body being white and the remainder brown. The mature caterpillars have the *Choerocampoid* form to a greater extent than any other of our species, the posterior thoracic segments being more than usually tumid; but in their markings exhibit the widest contrast from those of other genera, the main ground color being a rich brown with massive patches of white or yellow, seen most conspicuously on the sides of the first three pediferous abdomi-

nal segments, the sides and dorsum of the hinder abdominal segments and a narrower band along the lower sides of the thoracic segments, the latter bringing the tumid portion into higher relief; the tumid part is further distinguished by much mottling of lighter and darker colors, particularly in the form of light colored annuli. The chrysalids most nearly resemble those of *Papilio* but have the angulations still more prominent, the ventral bend bolder and the wing-cases more tumid. Their color is brown of various shades, often highly tinged with greenish and always streaked boldly and delicately with black.

EXCURSUS LI.—SOUTHERN INVADERS.

They have wander'd in their glee
With the butterfly and bee.

HEMANS.—*And I too in Arcadia.*

IMMEDIATELY upon the close of the glacial epoch, there was a movement of butterflies from the south northward, following by slow steps the retreat of the ice, some at nearer, some at greater distance. It would appear from sundry facts as if this movement were still going on; at any rate we find upon the southern shores of New England a number of butterflies belonging more properly to the extreme south which are struggling to maintain an existence on our shores, apparently unable to make any further considerable advance to the northward. Such are *Junonia coenia*, *Euptoieta claudia*, *Eurema lisa*, *Anthocharis genutia*, *Achalarus lycidas*, and perhaps one or two others. In addition to these, certainly, should be mentioned *Anosia plexippus*, a butterfly belonging to a preeminently tropical type, but which, as I have pointed out, makes annual northward movements of great magnitude, and when summer has closed, retreats again to the south, barely maintaining a permanent existence in the southern districts of New England.

Movements from the south northward in the nature of invasions, on account of the large numbers involved, are known to have occurred by direct observation in only a comparatively few instances, but such movements are easily inferred from the sudden abundance of an unknown butterfly or of one comparatively unknown upon our southern shores, indicating an attempt on the part of our southern butterflies to invade our territory, and if possible to establish themselves therein. Thus, *Chlorippe clyton* has on one or two occasions been found in considerable numbers in the immediate vicinity of New York, whereas its proper home is in the far south; an inhabitant of the middle states as well, it has on these occasions pushed its way to the north, but has not been able to maintain itself permanently; for it has never been seen within the territorial limits of New England. So, too, *Junonia coenia*, which has apparently gained a tolerably secure

foothold in southern Connecticut, has pushed its way along the warmer seacoast so as to have been taken in a few instances even on the shore of New Hampshire and of Maine, as far as Bangor. *Euptoieta claudia*, similarly a permanent resident of our southern edge, has been taken in eastern Massachusetts, both in the Connecticut valley and along the seacoast; and it has once or twice been found even as far as Portland. Perhaps there should be included among such butterflies *Hypatus bachmanii*, an inhabitant certainly of the extreme south and occurring in abundance in the southern of the middle states, rarely as far north as Philadelphia; this has plainly made some more or less extensive inroads to the north, since it has been taken occasionally in the vicinity of New York, about Boston and even in the very heart of the White Mountains, which it reached doubtless by some movement up the Connecticut valley.

But the plainest indications of such invasions are to be found among the Papilionidae. One such instance is known in *Callidryas cubule*, which appeared on one occasion in immense numbers in Rhode Island, where it does not permanently dwell, and has been taken on several occasions upon Long Island. Another, in *Xanthidia nicippe*, which, common enough in the south and even in the southern middle states, is ordinarily unknown in New England and New York, but in the year 1875 must have made an extensive movement to the north, since in the vicinity of Newburgh, N. Y., it became even more common than *Eurymus philodice* and was seen in eastern Massachusetts, while the only other instance of its occurrence anywhere in New England is in specimens I once saw, obtained in Norwich, Conn. The wide spread *Pontia protodice* is probably another case in point, for, while it seems to have but a precarious foothold upon our southern shore, it has been known to be taken in the vicinity of Montreal, which it must have reached by an exceedingly extended movement to the north, along the Hudson-Champlain valley.

Among the swallow-tails we have two striking instances, one in *Laertes philenor*, which, maintaining itself by a comparatively few individuals in southern Connecticut and perhaps by a few in eastern Massachusetts, occasionally appears in such numbers as plainly to indicate a northward movement of the throng that are found at no great distance in the middle states. The movements of *Heraclides cressphontes*, which until recent years was not known at all in New England, and has now established itself in the extreme southwestern corner, will shortly be related in full.

To this list should probably be added the following skippers: *Eudamus proteus*, a typical southern form, which occasionally appears in some numbers in the southwestern corner of New England; *Achalarus lycidas*, which, though less southern, nevertheless belongs conspicuously to the Carolinian fauna and which occasionally makes a foray into eastern Massa-

chusetts; *Hylephila phylaeus*, also distinctively southern and tropical in its distribution, which has sometimes appeared in considerable numbers on the southern coast; and finally *Erynnis atalua*, a southern butterfly which once in a while is taken in large numbers in Connecticut and even about Boston.

There are a number of other cases where southern butterflies have in one or two cases been taken singly in New England or its confines, wandering raiders from the southern armies, but those which have been related give a clew to the mode in which New England was originally colonized, and indicate that whether or not the process is still going on, there is at least a constant fluctuation in the components of its butterfly fauna, or in the relative abundance of those types which maintain a precarious foothold from year to year.

HERACLIDES CRESPHONTES.—The giant swallow-tail.

[The yellow emperor swallow-tail (Gosse); Cresphontes butterfly (Saunders); yellow banded swallow-tail (Maynard); the orange-dog (Hubbard); hog caterpillar of the orange (Comstock).]

Papilio cresphontes Cram., Pap. exot., II: 106-107, pl. 165, fig. A, pl. 166, fig. B (1779);—Ménétr., Enum. aulm. mus. Petrol., II: 111 (1857);—Felder, Spec. Lep., 22, 69-70 (1864);—Herr. Schaeff., Schmett. Cuba, 12-13 (1865);—Saunders, Can. ent., x: 48-50 (1878); xv: 234-235 (1883); Rep. ent. soc. Ont., 1878, 60-61, fig. 38 (1879); Ins. Inj. fruits, 377-380, figs. 380-381 (1883);—French, Rep. ins. Ill., vii: 139-140 (1878); Can. ent., x: 204-205 (1878); xiii: 177-179 (1881); Butt. east. U. S., 101-105, fig. 20-22 (1886);—Boll. Can. ent., x: 154-155 (1878);—Const., Rep. U. S. ent., 1880, 246-248 (1881);—Gundl., Rep. fis.-nat. Cuba, I: 280, pl. 5, fig. 2 (1866); Berl. ent. zeitschr., xxx: 132 (1866); Ent. Cub., I: 131-133 (1881);—Hubb., Ins. orange, 137-140, fig. 56, pl. 10, pl. 11, figs. 1-2 (1885);—Mayn., Butt. N. E., 50, pl. 5, figs. 69, 69a (1886).

Papilio thoas (pars) God., Encycl. méth., ix: 62-63 (1810);—Boisd.-LeC., Lép. Amér. sept., 31-36, pl. 12-13 (1833);—(pars) Lucas,

Pap. [Diet. plitt. hist. nat.], 56-57 (1838);—Hist. nat. Cuba, 482 (1857); Doubl., Arc. ent., I: 144 (1845);—Glover, Rep. U. S. dept. agric., 1858: 263-264 (1858);—Gosse, Lett. Alab., 170 (1850);—Morr., Syn. Lep. N. Amer., 7-8 (1862);—Dwight, Psyche, III: 327 (1882).

Heracles thoas Hübn., Samml. exot. schmett., II (1826-21).

Papilio thoas var. *cresphontes* Boisd., Spec. gén. Lép., I: 356 (1830).

Heracles oxylus Hübn., Verz. schmett., 83 (1816 ?).

? *Papilio oviedo* Gundl., Rep. fis.-nat. Cuba, I: 279-280, pl. 5, fig. 1 (1866); Ent. cub., 133-134 (1882).

Figured also by Abbot, Draw. ins. Geo. Oeml. coll. Bost. soc. nat. hist., I: Gray coll., 47 (ined.);—Glover, Ill. N. A. Lep., pl. 24, 5 figs. (ined.).

Not *Papilio thoas* Linn.; nor *Papilio cresphontes* Fabr., Godt., Lucas, Beisid.; nor *Priniceps herculeus* *cresphontes* Hübn.

"Ha!" I said,
"King of the butterflies."

KEATS.—*Endymion*.

Imago (14: 12). Head covered with moderately long, black hairs, usually implanted altogether on the sides of the front with yellow hairs, though these are occasionally reduced to a meagre line next the eye, and are usually supplemented by a small, round, yellow spot behind the antennae outwardly. Palpi wholly yellow. Antennae black brown, the joints of the apical half, excepting the last two or three, rather narrowly luteous at extreme inner base. Tongue black.

Thorax black brown above, the inner edges of the patagia, and a pair of small spots anterior to and on a line with each, one on the prothoracic lobes, the other between

them and the patagia, yellow; beneath wholly clay-yellow, including all the coxae. Femora covered with black scales but flecked with yellowish white upon the basal half of both inner and outer face, in the latter especially below, and in a line along the middle of the distal half of the upper surface, deepening apically; tibiae and first joint of tarsi naked, glaucous yellow, the under surface much infuscated, the remaining tarsal joints fusco-luteous or brownish, the lower surface very obscure. Spurs luteo-castaneous, luteous at base, spines piceous; claws castaneous, infuscated apically.

Wings above black brown, conspicuously marked with maculate stripes of rather pale yellow, which are continuous across both wings. *Fore wings* with a very few scattered scales above the discal cell along the course of the costal nervure; traversing the wing from the apex to the basal half of the inner margin is a broad, straight band of ten very large, more or less rounded, yellow spots, one in every interspace but the uppermost from the apex of the outer to the inner margin, and two more or less confluent in the medio-submedian interspace; their upper edges follow a nearly straight line (much more nearly than their more dentate lower edges) which runs from just within the termination of the anal vein to the tip of the second superior subcostal nervule; most of them are larger apically than basally; the first, counting from above, is sublunate; the second is subquadrate, generally nearly twice as long as broad; the fourth and fifth are generally of a similar form but more narrowed basally; the sixth and seventh are usually a little smaller and decidedly convex or angularly produced in the middle apically, rounded basally; the eighth and ninth confluent, with nearly continuous basal margin, and broadly serrate apical margin; the tenth subtriangular, very elongated, the extremely broad base extending from the middle half way to the base of the inner margin; the third most nearly resembles the fourth, but it is very generally confluent to a greater or less extent with the lower spot of the series next to be mentioned, which lies in the same interspace and forms thereby a very long, oblong oval, often four times as long as broad, the inner more rounded than the outer margin, sometimes intact, sometimes interrupted in the middle above by an oval spot of the color of the ground, of varying size, and when largest breaking the compound spot into its original parts but with opposing concave curves. The next series of yellow spots runs from the costal margin above the apex of the cell to the fourth spot of the series just described, and is composed of irregular elements: the lowest has just been mentioned; the next above it is a rounded, sublunate spot, at the extreme base of the interspace, containing the first spot of the previous series, though there is, rarely, a trace of a small triangular spot at the extreme base of the shorter interspace below; this is followed by a very small, triangular spot, with its broad base toward the costa, exactly above the apex of the cell, and above that elongated, confluent, powdery, longitudinal streaks, their inner edges nearly or exactly opposite the inner edge of the spot below, their outer often extending far beyond it, and generally ending above the middle of the spots beyond the cell. A third series of large yellow spots, three in number, extends in successive interspaces from the lower outer angle of the wing to the outer half of the fifth spot of the long row, their outer edges forming a slightly arcuate curve, more noticeable when a fourth small spot is present, generally round, occasionally transverse, in the middle of the third median interspace just beyond its large spot; of these three spots the middle is usually a little the largest, both the upper and the middle lunate or sublunate and rounded, the lowest transversely rounded, quadrangular; occasionally the submedian interspace is flecked faintly with yellow just below the middle, from the inner margin of the outer medio-submedian spot, half way to the inner yellow stripe. Fringe black, interrupted in yellow lunules in the middle of the interspaces in the lower three-fourths of the margin. *Hind wings* with a broad, basal, oblique, transverse, yellow stripe, with straight but powdery border, the outer border running from the middle of the basal half of the inner margin of the wing (previous to its deep recession) to the upper branch of the subcostal, crossing before or beyond the middle of the cell, suddenly bent at a little, sometimes much, more than a right angle, and running to the costa; the inner border of the stripe is subparallel to this, leaving only the extreme

base below the costal vein black; this stripe is in continuation of the oblique series of spots crossing the middle of the fore wing. In continuation of the lower and outer series of the same wing there is an arcuate series of very large and deep yellow lunules, subparallel to and distant from the outer margin, one to each interspace, the innermost with its form destroyed and its size vastly reduced by the deep emargination of the inner margin; they are subequal in size and about as large as the average of those of the great transverse series of the fore wings; the lowest subcostal and the median spots occupy about the middle of their respective interspaces; the others are nearly in a straight line with these, excepting the uppermost, which is removed inward by nearly its own width. Just before the emargination of the inner margin, and following the excised spot of the medio-submedian interspace is a velvety black, transverse bar, which scarcely reaches the lower median nervule, followed interiorly by a broad, orange red lunule, of similar size and somewhat similar shape, embracing it exteriorly, again followed by a velvety black lunule, sprinkled to a greater or less extent with caerulean blue. A large yellow oval spot, attenuated interiorly and divided to a greater or less extent by the upper median nervule into unequal parts, the upper the larger, is found just before the tip of the spatulate tail. The outer margin is interrupted with yellow lunules in all the interspaces, which include the fringe, otherwise black.

Beneath mainly yellow, not so bright and clear as above, but more nearly clay-yellow, with a greenish tinge where the reverse is black. *Fore wings* with much the same markings as above but much enlarged and extended, and to some extent combined. The main transverse series is much larger, and in the upper half of the wing combines with that depending from the costa at the apex of the cell, so as to cover all the intervening space, the spots merely separated by the black veins. The series at the lower outer corner of the wing becomes developed into a submarginal series, the spots found in every interspace fully opening on the outer margin, separated from each other by little more than the black veins, the outer border of the series subparallel, and, especially above, less than half an interspace distant from the outer margin, its uppermost spot larger and clearer than those next below, being the counterpart of the apical spot of the great transverse series of the upper surface, which is here transferred to the marginal series; with this exception, the spots diminish very regularly in size on either side of the second median interspace. Within the great transverse belt, especially away from the veins, the whole base of the wings is heavily powdered with yellow, giving a greenish gray, longitudinally streaked appearance to the cell. Margin and fringe interrupted with yellow, as above, but more deeply. *Hind wings* almost entirely yellow, including even the veins on the basal half of the wing. Across the middle of the wing is an arcuate band, consisting of a confluent series of strongly arcuate, outward facing lunules, strongly attenuated at the nervules, bent at a broad angle at the middle lunule, that in the second subcostal interspace usually occupying, but sometimes failing to reach, the extreme base of the interspace, the upper occupying the reverse of the black interval on the upper surface, the lowermost, the medio-submedian interspace just before the emargination; each includes a powdery lunule of similar arcuation, but generally very slender, of caerulean blue, sometimes tempered with brown, especially next the nervules, and the lowest also includes, just before its outer extremity, a large transverse, rounded orange bar, yellow next the lowest median nervule, and then continuous with the outer yellow, this orange bar corresponding to that of the upper surface. Just before the end of the cell, separated from the vein connecting the subcostal and median nervules by a slender streak of yellow, is a bent and rather narrow black bar, occasionally flecked next its outer margin with a line of caerulean blue. The base of the upper two median interspaces, and to a slight extent, generally, the lower subcostal interspace are heavily flecked with rusty orange. On the margin, the yellow lunules of the interspaces on the upper side are enlarged, leaving between them and the yellow apical ground of the wing only a narrow series of transverse black lunules or arcuate black bars, touching the margin and including the fringe only at the nervule tips;

veins of this part of the wings marked in black; the oval yellow patch of the tail as above, but sometimes enlarged.

Abdomen above rather narrowly black; below and on sides, and encroaching somewhat above, uniform yellow, of the tint of the under surface, the apical segment wholly yellow; valves of male (35:21-23) testaceous and smooth externally, with well rounded surfaces, gently tumid, the upper apical portion curved gently inward, the lower border gently, the upper more strongly arcuate, the apex broadly and very regularly rounded; armature consisting of an arcuate lamina, subparallel to the lower and outer margin, reaching nearly to the tip, and there connected by a corneous, thread-like lamina to the upper base, the edge of the first-named portion being pretty well but irregularly crowded with very small, moderately stout, recurved teeth; the lamina highest next tip of valve.

Measurements in millimetres. Length of tongue, 21-23 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	50.	59.	63.	63.	68.	70.
antennae.....	16.	18.75			21.	
hind tibiae and tarsi..		15.25	17.	17.	17.75	18.75
fore tibiae and tarsi..	8.5	11.5	12.	12.	12.	13

Tails of the hind wings ♂, 13.5-15 mm., ♀, 15-16.5 mm.

Described from 5 ♂, 3 ♀, half of them from New York and Massachusetts.

Egg (66:3). Surface without apparent markings, but with a texture like bluish ground glass overlaid completely by a thin and uniform gummy secretion which gives it a scabrous appearance, with numerous, irregularly distributed, short, microscopic filaments, the whole of a dirty brownish yellow. Hubbard describes it as "smooth and pearly in lustre, with a dull red or reddish yellow tinge." The micropyle (68:19) consists of four or five rounded cells with coarse walls, in a cluster about .025 mm. in diameter. Height of egg, 1.1 mm.; breadth 1.3 mm.; at base, 1 mm.

Caterpillar. First stage (73:1). Head (79:62) black becoming brownish yellow posteriorly, the space between the true and false frontal triangle whitish. Hairs dark ferruginous, as long as the width of the triangle, sparsely distributed, and pretty uniformly, excepting at the extreme summit. Body blackish brown mottled rather obscurely with umber, the first thoracic segment dull lemon yellow, and the second, third, seventh and eighth abdominal segments of the same color, as also to a certain extent the dorsal parts of the first abdominal segments; the mamiform prominences are pale but dull umber, the large ones of the first thoracic segment dull lemon yellow; hairs dark ferruginous, sometimes luteo-ferruginous. Length, 3.5 mm.; breadth of head, .8 mm.; of last abdominal segment, .6 mm.

Second stage. Head (79:63) yellowish brown, more or less infuscated, darkest in the upper half of the triangle, the ocellar field and a large frontal spot on either side above. Body brown of a variable intensity and more or less mottled with darker and lighter or warmer shades, saddled with a white oblique blotch on either side, meeting above, mostly upon the third, but above also on the fourth and below also on the second abdominal segments; a similarly colored roundish blotch on the summit and upper half of the sides of the eighth abdominal segment, most conspicuous on the sides, encroaching also on the adjoining segments but especially on the seventh. The prominences as in the first stage but somewhat less pronounced. So, too, the shape of the body is much the same but with a tendency toward an inflation of the thoracic segments. Length, 8 mm.; breadth of head, 1.2 mm. Described from specimens preserved in glycerine.

Third stage. Head (79:64) uniform glistening smoky brown, the mouth parts paler. Body dark brown with the same markings as in the preceding stage and with the same prominences, but these very much reduced in height, and more nearly uniform, bluntly rounded, those of the first thoracic segment, however, still the largest and the only ones higher than broad. There is also a slender and at first rather vague, oblique, white

stripe on the sides of the first and second thoracic segments. Length about 12 mm.; breadth of head, 2 mm. Described from alcoholic specimens.

Fourth stage. Head (79: 65) pale castaneous, pale beneath with the mouth parts, and with a pale, oblique stripe crossing the upper limit of the ocellar field; ocelli pale with a blackish base. The body has now assumed the form and markings of the adult, excepting that the lenticles are higher, being mostly hemispherical and of a glistening, ferrugineo-castaneous color, that the lighter colors are still white and that the posterior patch has a median triangular dorsal tongue of the darker color on the seventh segment. Length of body, 30 mm.; breadth of head, 3 mm. From blown specimens.

Last stage (76: 16). Head (79: 66) pale castaneous as in the preceding stage, but with no oblique pale stripe. Body dark, rich, ferruginous brown, massively marked with yellowish cream color: in front with a broad, equal, oblique stripe, crossing the first, second and front half of the third thoracic segment, posteriorly in the middle of the side of the body, in front meeting in advance of the osmaterial. In the middle with a saddle-like spot, formed of the union of two triangular spots, one angle at the middle of the dorsum of the fifth abdominal segment, another at the front base of the first pair of prolegs, and the third near, but not quite at the front edge of the second abdominal segment just above the spiracle; above, these two triangles blend broadly along the front edge of the third abdominal segment and the color of the whole is more or less obscured by a mottling of impure brownish spots. The hinder spot occupies the end of the body from the front margin of the seventh abdominal segment backward, much blotched with brown above, especially on the seventh segment, and separated from the dark ground of the parts in advance by an oblique line running from the front margin of the seventh segment at the suprastigmatal line toward the medio-ventral line of the posterior edge of the eighth abdominal segment. The dorsal parts of the body, on the darker ground, are pictured with cream or dull lemon yellow in cloudy longitudinal streaks on the fifth and sixth abdominal segments, with duller yellow in annuli and small round spots in advance of the saddle-shaped spot, the annuli at the base of the dark, brownish ferruginous, opaque lenticles. Under surface of the body between the outer side of the prolegs, yellow on the abdominal segments, the prolegs with a basal, larger, and apical, smaller, longitudinal stripe of the dark fuliginous which marks uniformly the infrastigmatal region, the basal stripe continuing narrowly in front upon the segment itself. Spiracles concolorous. Osmateria deep vinous red. Legs dark olivaceous, infuscated outwardly at base in transverse bands. Length, 5.5 mm.; breadth of head, 4.5 mm.; of third thoracic segment, 12 mm.; of eighth abdominal segment, 7 mm. Described from blown specimens.

A specimen of a nearly full grown caterpillar shown me alive, but in a dying condition by Mr. B. P. Mann had the front pair of prolegs greatly aborted; the under surface of the third abdominal segment had only a pair of slight mammiform elevations, each with a sessile crescent of hooklets; these last could scarcely ever have been brought into use, yet they were as well developed as usual; the markings on the sides of the prolegs showed that no part was actually wanting but only that all the fleshy parts were excessively shortened.

Chrysalis (85: 8-10). Nearly uniform dead leaf brown, sometimes with a greenish tinge, the head, prothorax and front, below the basal wing tubercle and half way across the wings, darker, warmer brown, the laterodorsal tubercles of abdomen blackish brown, the spiracles testaceous. Besides, the hinder edges of the movable abdominal segments are lavender, there is a broad, oblique, faint cloud of brown running on either side from the middle of the outer margin of the wings, toward the middle of the mesonotum, and everywhere the chrysalis is more or less marked with fine, black, almost velvety black lines; particularly the veins of the wings, at least about the cell, are marked with black and a tortuous-sinuous thread runs close and subparallel to the hinder margin of each abdominal segment on the ventral as well as the dorsal surface. There is a blackish brown stripe above from the base of the ocellar tubercles to the mesonotal wall and the whole front of the mesonotal wall is transversely variegated with continuous, slender belts of black, black-brown and rich burnt umber. Cremastral hooks dark castaneous.

Length, 40 mm.; height, 11.5 mm.; width at ocellar tubercles, 6 mm.; at basal wing tubercles, 9.5 mm.; at stoutest part of abdomen, 12 mm.; at tip of cremaster, 2.5 mm.; height of mesonotal tubercle above dorsal curve, 3.5 mm. From dried specimens.

Geographical distribution (27:2). This, the largest North American butterfly known, is, strictly speaking, an inhabitant of the tropics, but east of the great plains it is entirely at home throughout the whole of our Carolinian fauna, and has invaded, especially of recent years, many of the northern states. It is found throughout the Antilles and Central America and through the northern part of South America, New Grenada, Venezuela and northern Brazil; and in all this region is accompanied by another form scarcely to be distinguished from it, which extends southward through the Amazon region to the tropic of Capricorn. In the United States it occurs in the greatest abundance in all the southern states south of latitude 35°, and has been known for a long while from many of the states further north. It was recorded from New York even as long ago as 1864, and it appears by the statistics of recent years that it has been slowly and steadily invading the north to a greater and greater extent. It is now found fairly well established in all the states south of latitude 42°. It does not appear to have extended westward very far, being probably limited by the eastern border of the great plains. The westernmost locality from which it has been reported in the northern portion of its region are St. Louis, Mo. (Riley), eastern Kansas (Snow), Davenport, Iowa (Putnam), Wisconsin, occasionally as far north as Lake Winnebago (Hoy). This last indicates also one of the northernmost points from which it has been obtained in its western circuit; for in Illinois it has only been reported from Aledo, thirty miles south of Davenport, Io. (Putnam), and Galena (Bean)—though Dr. Fitch received in 1854 a specimen from Dr. J. C. Harris, taken at Ottawa in this state—and in Indiana from Greensburgh (Shannon); but it has also been taken in Michigan at Lansing (Cook), even near Marquette on Lake Superior in 1885, the northernmost point from which it is reported (H. Edwards), was said by Kellicott to be more common in barnyards in 1888 than *Pap. polyxenes*, and must occur in the vicinity of Detroit since it has been found in numerous places in western Ontario. These are, to pass from west eastward, Amherstburgh and other parts of Essex Co. (Reed, Denton, Lowe), Point Pelee (Saunders), Port Lambton on the St. Claire (Lowe), and Chatham, Kent Co. (Saunders). In the central portion of that part of Ontario which rests upon the lake of that name, it has been found at St. Thomas, Middlesex Co. (Eccles), Thedford (Watson), London (Saunders, Reed), where it is not now found (Can. ent., xix:225), Oxford Co. in 1887 (Geddes) and Long Point, jutting into the lake (Moffatt); while in the eastern region it has been taken at Dunnville, Haldeman Co. (Lowe), Dundas, Wentworth Co. (Murray), Hamilton (Moffatt, Murray), Grimsby, Lincoln Co.

(Saunders), Ridgway, Welland Co. (Moffatt), and even Toronto (Saunders). On the opposite shore of the lake it was recorded from Ohio by Kirtland many years ago and is still found there. In New York it has swarmed at Rochester (Bunker) and is recorded from Brockport by Bruce and at Poughkeepsie and Rheinbeck by Dwight and DeGarmo. The most extraordinary occurrence of all in the east is that of at least four specimens taken or seen by Mr. Jack at Chateaugay, about thirty miles west of south from Montreal. In the vicinity of Philadelphia it has been taken rarely (Blake) and is recorded from the neighborhood of New York from Morris Plain, N. J. (Neumoegen), Staten Island (Davis), and Rye, West Chester Co., N. Y. (Van Wagenen).

These last localities would be sufficient warrant for including it among the butterflies of New England, but it has strangely extended far to the eastward along the coast. Apparently it became domesticated in southwestern New England about 1875, for in 1874, as above noted, it was found by Van Wagenen in West Chester Co., N. Y. (where it has remained ever since), and a specimen was taken in New Haven, Conn., by F. S. Smith in the summer of 1875 (Verrill). In 1877 it appeared in Fairfield Co. (Peck), and in that and succeeding years at Berlin, Conn. (Coleman). In 1880 it established itself permanently in Poughkeepsie on the Hudson (Dwight) and probably in a considerable part of the southern coast of New England; for in 1882 it made further excursions, this being the year when it was taken by Jack at Chateaugay, doubtless specimens which had followed northward up the Hudson-Champlain valley; while Massachusetts was invaded by way of the Connecticut and the sea-coast, Goodell capturing specimens at Amherst in the latter part of July, and Brackett seeing or capturing three specimens in Boston Highlands between June 24 and July 15. That they obtained a foothold in this section, if only a temporary one, is proved by the capture of five specimens in August, 1883, at Worcester (Sanborn), of others at Sharon (Brackett), and by the discovery of caterpillars on trees in the Botanic Gardens at Cambridge at the same time (Seagrave). Specimens of the butterfly were also taken by others in Cambridge and Newton. Since then, there is no report of its appearance north of the southern seaboard of New England and the Hudson valley, excepting the singular statement of no less an authority than Mr. Henry Edwards, who writes me that in August, 1886, he saw a worn specimen on the wing at Eastport, Me., and another near Augusta while going from Portland to St. John, N. B.* He adds: "I could not by any possibility be mistaken in the species. I could have caught the one at Eastport."

Haunts. According to Doubleday it flies "in the pathways of the

*The reported occurrence of this species in New Brunswick (Can. nat., xi:239) was a case of mistaken determination, as I am informed by Mrs. Heustis herself.

woods"; Lowe says that it was once common in Ontario "in almost every clover field"; according to Gosse it frequents the "stable yard," and Hubbard states that in the south it "is seen everywhere flitting about in the orange groves," and "it is a common sight to see a dozen or more individuals hovering over a garden bed of Phlox or Zinnias."

Oviposition. Hubbard states that the eggs are "deposited singly, invariably upon the youngest and most tender shoots, usually upon the tips of the budding leaves. . . . The first eggs are deposited . . . as soon as the new growth appears upon the orange trees. The eggs hatch in ten or twelve days." Mr. Howard, however, he tells us, found the eggs "upon the older leaves and on the twigs" of orange trees about Savannah; French gives six days for the period of the egg, and Wittfeld, in southern Florida, had them hatch in four days. "The ovaries," Mr. Hubbard says, "contain over five hundred eggs, the laying of which occupies the female many days; she scatters them over a wide area, seldom depositing more than four or five upon a single plant"; and Glover says she takes care "not to place more than one or two upon a leaf." Of three specimens seen by me attached, two were laid upon the upper surface of one leaf and one on the same surface of another. On the other hand Mr. Beutenmüller, who found no less than fifty-five larvae in one day near New York City, writes that the eggs are laid "singly on the under side of the leaf"; Saunders found them "laid singly and usually on the upper side of the leaf, to which they were firmly attached."

Food plants. The caterpillar will probably feed upon any of the Rutaceae, as it has been generally found on some member of that group, especially upon the orange; it has also been known to feed on the lemon (Saunders), has been frequently taken on the hop-tree, *Ptelea trifoliata* (Riley, Snow, Saunders, Barnes, Beutenmüller), and on several species of prickly ash, *Xanthoxylum americanum* (Abbot, Riley, Doubleday, Seagrave, Snow, Dwight, Saunders), *X. clava-herculis* (Abbot, Major LeConte, Boll) and a Cuban species called *ajuda* (Gundlach); further, on an introduced member of the family, *Dietamnus fraxinella* (Kirtland, Saunders). It is not, however, altogether confined to Rutaceae, but has been found on widely different groups. Hubbard says it is found commonly in the swamps of Florida feeding upon the tupelo, *Nyssa multiflora*, one of the Cornaceae; as well as on the red bay, *Persea carolinensis*, one of the Lauraceae; while Shannon even found it feeding in Illinois on the Lombardy poplar, *Populus dilatata*, one of the Salicaceae. In Cuba, Dr. Gundlach has found it also on *Piper peltatum*, *P. umbellatum* and *P. mollicornum*, belonging to the pepper family, Piperaceae.

Habits of the caterpillar. "The young caterpillars feed at first only upon the tenderest leaves, but when well grown demolish both leaves and shoots which have not hardened into wood," sometimes completely defo-

liating young trees (Hubbard). According to Coleman, they appear to feed wholly in the daytime. When not feeding they remain rigidly motionless on the surface of leaves, and then, particularly when young, as remarked by several persons, they closely resemble the excrement of birds, affording, no doubt, a considerable protection against insectivorous animals. Mr. Seagrave tells me that the caterpillars he found in Cambridge remained on the under side of the leaves when young, and ate only the tenderer parts between the veins of the leaves; when partly grown they were also found on the upper side of the leaves, and when they became still larger they rested upon the branches and the long leaf-stem of the prickly ash, eating the entire leaf, excepting the midrib. The osmateris emit a very disagreeable odor. The caterpillar stage generally lasts about a month, but may be as short as twenty days.

Hubbard suggests, as a means of keeping the insect in check, the extraordinary device of shooting the butterflies with dust-shot from a fowling-piece, as they cluster about flowers! "An insect," he remarks, "which has a spread of wing of four or five inches affords a by no means despicable object for target practice." Gunning for butterflies may yet be introduced into the list of southern sports.

Pupation. The caterpillar is said to generally suspend itself upon the twigs or branches or even the leaves of the tree that has nourished it, though Dwight found some suspended "under the stones of farm walls." The hibernating chrysalids, according to Comstock and others, so closely resemble the color of the bark of the orange tree that it is difficult to detect. "The irregular projections of the head and breast, and sundry markings resembling cracks in the bark, and even minute lichens growing upon it, bear out the striking likeness to a bit of a knotty orange branch most perfectly." The summer chrysalids remain suspended for from six to sixteen days, according to the season, ten to fourteen being the most common. French had two chrysalids change to butterflies in August, after twenty-seven and thirty-nine days, while their comrades changed in fifteen and sixteen days, and his general experience in Illinois showed a range of from fourteen to twenty-four days. Boll mentions one interesting chrysalis from caterpillars of 1875, which did not give the imago until April, 1877!

Life history. There are four broods of this butterfly in Florida, according to Comstock and Hubbard, between February and October; three in northern Texas, according to Boll, the caterpillars being found in April and May, July, and September and October; in both places, as in the north, the chrysalis hibernates. At the northern limit of its distribution, there are two broods, the butterflies appearing early in June or even in the last week of May, flying throughout June, and the second brood appearing again at the end of July; they evidently continue to emerge from the

chrysalis throughout August, are laying eggs, to judge from the caterpillars found, at least throughout August, and fly throughout the greater part of September and even into October; the caterpillars sometimes do not reach chrysalis until the middle of October. The whole period from egg to imago in a single season may be as many as sixty or as few as twenty days.

Late in August, 1883, Mr. H. S. Seagrave discovered on the under side of leaves of the prickly ash in the Botanic Garden, Cambridge, a couple of recently hatched larvae of this species, close beside their egg-shells. Subsequently others were found upon the same tree, and some of them reared to maturity, producing butterflies of the normal size. Later, others were found in different stages of growth, and as they continued to appear even to the time of frosts, some being found only half grown on leaves which had fallen from the trees, about six weeks later than those first found, Mr. Seagrave thought that the later caterpillars belonged to a succeeding brood; but this can hardly be the case, but rather later individuals of the second brood, the butterfly continuing to lay, without regard to the impossibility of her progeny's being able to grow to maturity; frosts must here as elsewhere kill off the belated caterpillars. All the later caterpillars which Mr. Seagrave reared produced much undersized butterflies.

Habits and flight of the butterfly. On alighting, the butterfly rests on the upper side of leaves, with spread wings (Wittfeld). "The contrast," says Gosse, "between the prevailing colours of the upper and under surface is very observable, as the insect floats carelessly along, slowly flapping its voluminous wings, or rests half expanded, to sip the slushy mud in the stable-yard; when it has a magnificent appearance." According to Doubleday, it "alights on the ends of projecting branches or on a projecting dead twig, sitting with its wings expanded, drooping, as we set Lepidoptera in England, or rather more so than we commonly depress them. . . . I never saw it close its wings over its back." Its strong flight makes it difficult to capture, according to Grote, and DeGarmo writes that it "is a very vigorous insect, with a strong, steady stroke of wing, more like the flight of a bird than any other variety about here"; and Uhler speaks of it as "sailing with dignified beauty in the country about Hagerstown, Md."

Protection. The protective colors of the caterpillar and chrysalis have been alluded to above, as well as the odor of the osmateria of the caterpillar. "No birds attack it," writes Dr. Neal, "though often exposed. The shrike, that is almost omnivorous, will not touch it, nor will the bee martin nor the mocking bird." From fifty odd caterpillars found by Mr. Beutenmüller, near New York, not one was parasitized.

Enemies. Yet it finds foes enough, and perhaps the northern locality may account for the immunity noted by Mr. Beutenmüller. Hubbard writes:—

A *Tachina* fly, with a hairy body, and somewhat larger than a common house-fly, which it superficially resembles, attacks the caterpillars when partly grown, and deposits upon each several elongate, oval, white eggs; these hatch maggots, which penetrate the skin of their host and feed upon its body-contents, eventually killing the worm. The tachinized caterpillar usually attempts to pupate, but strength fails and it dies suspended in its silken loop. The parasitic maggots eat their way out and drop to the ground, in which they form oval puparia. They emerge as flies in twelve or fifteen days, or, if the season is far advanced, remain in the ground during the two or three months of winter, and issue with the return of warm weather in February. From four to eight flies are bred from a single Orange Dog. [He also adds:] From the chrysalis there sometimes issues, instead of the butterfly, a four-winged fly. This parasite [*Chalcis robusta*] is a large and handsome member of a family, the Chalcididae, composed for the most part of minute forms. It is 8.4 mm. (3-10 inch) long; in color black, with golden-yellow legs. The posterior thighs are swollen and adorned with an oblique band of black across the middle. The wings are smoky. The head and thorax are very coarsely punctured, and clothed with short, golden hairs. The fly in quitting its host makes a large, round hole in the side of the chrysalis. All the specimens obtained emerged in June or July from pupae of the second brood. There can be no doubt that this parasite would in case of undue multiplication of the Orange Dog become an efficient check upon its increase. At present, however, it is somewhat rare (Ins. orange, 139).

Pteromalus vanessae (89: 3) has also been bred from this insect by A. H. Mundt in Ohio and W. H. Edwards in West Virginia, together with *Hemiteles humeralis*, which is a parasite of this enemy. Finally Dr. Neal, writing from Florida in 1883, says, "The Mutilla (cow ant) this year has nearly cleared my trees of the crespontes; it snips out a piece from the abdominal ring, takes a sip of the fluid, and then the 'sugar-ants' finish the work."

Desiderata. Whether the northern leap of this insect is a permanent acquisition or not, or whether its northern boundary is an ever fluctuating one, is an interesting question to determine. Whenever it appears in new localities it should be noted, and when it disappears record is equally worthy. Where and how is the change made from two to three and to four broods in the season? What is the meaning of the long continuation of some chrysalids? Do they tend to combine butterflies of distinct broods? The habits and postures of the butterfly are insufficiently known and the dipterous parasite undetermined. Has the butterfly any special means of protection, through odor or any other thing? So large and striking a butterfly would seem to be more than ordinarily in need of it.

LIST OF ILLUSTRATIONS.—*HERACLIDES CRESFONTES*.

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| <i>General.</i> | <i>Chrysalis.</i> |
| Pl. 27, fig. 2. Distribution in North America. | Pl. 85, fig. 8. Colored. |
| 89: 3. <i>Pteromalus vanessae</i> , a parasite. | 9, 10. Outlines. |
| <i>Egg.</i> | <i>Imago.</i> |
| Pl. 66, fig. 3. Plain. | Pl. 14, fig. 12. Male, both surfaces. |
| 68: 19. Micropyle. | 35: 21-23. Male abdominal appendages. |
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| 76: 16. Mature caterpillar. | |
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PAPILIO LINNÉ.

Papilio Linn., *Syst. nat.* 10th ed., 1: 458 (1758)*.

Pieris (pars) Schrank, *Faun. boica*, il, 1: 152, 100 (1801).

Princeps Hübn., *Tent.*, 1 (1806).

Amaryssus Dalm., *Vetensk. Acad. handl.*, xxxvii: 60, 85 (1816).

Jasonides (pars) Hübn., *Verz. bek. schmett.*, 83 (1816).

Mariposilla que vas volando
Entre las flores de este jardín,
Que inquieta vagas acariciando
Rojos claveles, blanco jazmin.

Deja que mire tus alas bellas
Y aque de ellas,
El polvo de oro lindo y sutil,
Que encanto presta, que dá hermosura
A tus colores, á tu figura,
Como las auras al fresco abril.

No desdenosa mi lado dejes,
Que aunque te alejes,
Tras tu belleza siempre he de ir,
Cuál tras las ondas va el pececillo,
Tras del diamante su puro brillo,
Y tras del cielo su azul zafir.

CORTÁZAR.

Imago (57: 2). Head large, clothed with not very long, erect hairs, longest just in front of the antennae, very short posteriorly. Front somewhat tumid, a very little protuberant down the middle below, the greater portion projecting a little beyond the front of the eyes though but slightly above the middle; slightly depressed above, the lateral carinae war'ing; below the antennae the front is fully as high as broad and of about the width of the eyes on a front view; upper border projecting very narrowly between the antennae, where also, as a little below, there is a slight, longitudinal, median sulcation and two faint ridges run at right angles to each other in front of and partially limiting the antennal pits; lower border broadly rounded. Vertex a little tumid, slightly protuberant behind in the middle, forming a very broad, rather low, transverse ridge, the middle third of which is straight and transverse, the outer thirds with broadly rounded tips directed angularly forward; the portion in front is very slightly tumid, separated by a rather distinct sulcation from the ridge, but connected directly with the front. Eyes rather large and very full, naked. Antennae inserted with their anterior half in the middle of the summit, separated by a slender ridge only scarcely broader than the thickness of the crust of the second antennal joint; a little longer than the abdomen, composed of thirty-four joints a little constricted at their bases on the inner side, the apical ten forming a triquetral club, the angles of which are rounded and the outer surface a little hollowed; club from two and a half to three times as broad as the stalk and four or five times as long as broad, increasing very gradually in size so that the inner limit of the club is indefinite, the third and fourth from the tip largest, the last two joints forming a well rounded apex, the last joint being very small indeed, instead of rather large, as in the other native genera of Papilioninae; inner edges slightly serrate. Palpi very minute, rather stout, reaching the middle of the front of the eye, heavily beset with scales and fringed with not very long hairs curving strongly upward.

Prothoracic lobes obsolete. Patagia very small, flat, scarcely three times as long as broad, the base forming an elongated oval, the apical half a nearly equal posterior lobe, half as broad as the base, slightly constricted in the middle, curved a little outward, the apex well rounded.

Fore wings (40: 1) twice as long as broad, the costal margin very slightly irregular

*I have elsewhere given my reasons for thinking that this name should not be applied here. See above, pp. 390-391 and also *Proc. Amer. acad. arts sc.*, x: 238-240.

near the base, the basal three-fourths very broadly convex, the apical fourth curved a little more strongly especially in the ♀; outer margin very broadly and slightly sinuous, having a general direction at right angles to the apical part of the costal margin, the angle rounded off, the inner margin straight, very slightly and broadly emarginate in the middle, the outer angle well rounded off. First superior branch of subcostal nervure arising just beyond (♂: 15 ♂), or just before (♂: 16 ♀) the middle of the outer two-thirds of the upper margin of the cell, the second a little more (♂) or a little less (♀) than half way from this to the apex of the cell, the third at the apex, and the fourth scarcely less (♂) or a little more (♀) than one-third the distance from the apex of the cell to the outer border; cell a good deal more than half as long as the wing and nearly three and a half times longer than broad. At the origin of its fourth branch the median nervure is raised above the continuation of its basal half by rather more than the width of the last median interspace at its base; cross vein connecting median and submedian near the base directed straight downward until close to the latter and then curved outward.

Hind wings with the costal margin greatly shouldered next the base, the angle rounded off, beyond scarcely convex as far as the tip of the costal nervure, where it begins to curve toward the outer border leaving no definite angle; outer border considerably crenulate, greatly produced in the median region, in the anterior half of the wing curving quite regularly, fullest in the lower subcostal region in the ♀, in the upper subcostal region in the ♂, but directed at a very broad angle with the costal margin and at nearly as broad an angle with the posterior half of the border, which is slightly concave, except in bearing at the tip of the upper median nervure a very long equal expansion, rounded at the tip and fully four times as long as broad; just before the middle of the medio-submedian interspace it suddenly recedes with a rounded angle for a considerable distance and then resumes its former course; inner border narrowly folded, a very little concave, the angle rounded off. Subcostal nervure nearly straight between the bases of the first two nervures; vein closing the cell slightly shorter than that uniting the bases of the second and third median nervures.

Fore femora as long as (♀) or much shorter than (♂) the fore tarsi, the tibiae about five-sixths the length of the tarsi; middle femora and tarsi of equal length, the tibiae as long as (♀) or somewhat shorter than (♂) they; the three principal parts of the hind legs either of nearly equal length, the femora a very little shorter (♀); or, increasing rather regularly in length outward, the tarsi fully a third longer than the femora (♂); hind femora either equal to the fore femora and about five-sevenths the length of the middle femora (♂); or, equal to the middle femora and a little longer than the fore femora (♀); hind tibiae scarcely longer than the middle tibiae and a quarter (♂) or a half (♀) longer than the front tibiae; middle and hind tarsi of about equal length and more than a fifth longer than the front pair. Femora scarcely fringed with short, delicate hairs. Tibiae armed beneath on either side with a row of rather infrequent, small and rather slender spines; on either side above with a double row of similar spines and at tip with a pair of equal or almost equal, very long and very slender spines. First joint of tarsi equal to the second, third and half the fourth together, the third and fourth equal and slightly shorter than the second and fifth, which are equal; joints armed on either side beneath with a row of very short and rather slender and frequent spines, the apical ones of each joint and three or four scattered along the inner row of the basal joint a little longer; above channelled slightly along the inner side and there devoid of scales, but still furnished with four rows of smaller, almost recumbent scales, those on the outer side but vaguely traced; claws very long and slender, compressed, slightly but sharply heeled beneath at the very base, the basal three-quarters of the inner edge straight, the upper very broadly convex, the apical fourth tapering to a delicate point and curved somewhat strongly downward; paronychial and pulvilli wanting.

Abdomen with the second segment of the male only a little longer than the first and equal to the third; beyond, the segments decrease slightly in length, the middle of the dorsum of the eighth developing a posterior hook as long as itself, broadly expanding

baseward, the part beyond rather stout, its extremity subapiculate. Valves elongate triangular with rounded angles, broadest beyond the middle, much longer than broad, armed within by an inferior, straight, corneous rod, bearing on its apical half minute denticulations.

Eggs. Nearly globular but slightly broader than high by the truncation of the base, showing no depression above, smooth and glistening, the granulation of the surface being almost invisible.

Caterpillar at birth. Body subcylindrical, a little angulated at the lateral line, a little tumid on the thoracic and first and second abdominal segments, very slightly attenuated behind. There is a subdorsal row of small papillae, minute on the abdomen, one to a segment, bearing short hairs; there is also a supralateral row of tubercles, one to a segment, each surmounted by conical warts beset with whorls of six to eight bristles, those of opposite sides at right angles to each other, and a central longer one. On the first thoracic segment there is a small accessory tubercle at the postero-interior base of the one mentioned; there is also a suprastigmatal row of small compound warts bearing bristles, one longer than the rest, an infrastigmatal row of clustered, low, broad tubercles each surmounted by a small wart bearing a bristle, and a ventrostigmatal series of numerous bristles to a segment; a few hairs are scattered irregularly over the surface seated on very minute warts.

Mature caterpillar. Head small, broadest at the upper extremity of the ocellar field, fully as broad as high; a little full and well rounded next the ocellar field, beneath nearly straight; above the broadest point tapering a little, with a slight curve to form rather a high dome, which is interfered with by the considerable depression of the middle suture at the summit, leaving either half a little vaulted and yet slightly depressed on top. Head considerably deepest at its broadest point, the front highly appressed, sutures a little impressed; covered with minute, irregular, transverse, impressed lines, and abundantly and pretty uniformly supplied with exceedingly short, delicate hairs, arising from scarcely perceptible wartlets; triangle small, as broad as high, scarcely reaching more than two-fifths way up the front. Antennae with the first and second joints together forming a very broad, slightly elevated dome, the third slender, fully twice as long as broad, equal and cylindrical; fourth very minute. Ocelli six in number, three arranged in a scarcely curving row, its convexity forward and a very little downward, at about equal distances apart, a fourth below the third, counting from above, being midway between the first and fourth and on a line with them, a fifth directly behind and scarcely above the first, and as near it as the first is to the second; and the sixth behind the second, at equal distances from the first and third and at scarcely a less distance from the second; all hemispherical and of nearly equal size, but the fifth and sixth a little less prominent. Labrum moderately large, pretty broad, the front margin very deeply and angularly excised. Mandibles pretty large, stout and broad, tumid, the edge straight, sharply but not very deeply dentate above, smooth below. Maxillary palpi very small, the penultimate joint scarcely longer than broad, the last very small. Spinneret rather small, scarcely tapering, moderately long, recumbent.

Body large and plump, largest on the third thoracic segment, tapering rapidly forward, the first thoracic segment being scarcely more than half the diameter of the third, and more gradually backward, the last abdominal segment being fully as large as the first thoracic; the segments are very slightly arched; there is an inconspicuous laterodorsal row of suppressed warts, and the body is covered abundantly but not profusely with infinitesimal warts, each bearing an exceedingly short, delicate hair. In the earlier stages the body is furnished with tubercles, which become proportionally smaller in every stage; in the fourth stage they are arranged as follows: a subdorsal series of conical warts on the second and third thoracic segments placed centrally; a laterodorsal series of tubercles bearing thorny wartlets, placed centrally on the thoracic, and first to ninth abdominal segments, those of the thoracic segments, and especially the hinder two, twice as long as the others; on the first thoracic segment a pair of supralateral tubercles like those of the laterodorsal series, but as large

as the thoracic ones, and placed anteriorly on the first thoracic segment; and finally a laterostigmatal series of minute, spiny tubercles, placed centrally on the thoracic and first to ninth abdominal segments, becoming stigmatal on the first thoracic segment. Osmaterium having the main stem rather short, appressed and broad, about half as long as the forks, the latter diverging at about a right angle, curving a little backward and tapering to the tip. Spiracles very small, scarcely twice as long as broad. Legs stout and large at base, beyond rather slender, a little appressed, the claws moderately large, considerably curved, tapering, a little hooked at the base. Prolegs stout, short, scarcely tapering, the ventral ones armed at tip with about fifty hooklets arranged in a triple row, straight for most of its course, curved at its ends; the hooklets have an exceedingly long, equal base imbedded in the integument, the exposed end being short and stout, thickened and then tapering, strongly curved and bluntly pointed.

Chrysalis. Body moderately uniform, subcylindrical, tapering posteriorly; angular prominences mostly confined to the front, throughout somewhat rugulose; the abdomen occupies a little less than two-thirds of the body. Viewed from above, the body is slightly wider at the third abdominal segment than at the basal wing tubercles, the line between them slightly bent inward at the girth; behind, the body tapers very regularly; in front it tapers very rapidly with a slight concavity as far as the anterior extremity of the mesothorax and then continues nearly parallel to the base of the ocellar prominences. Viewed laterally, the prothorax is a little tumid above, the general slope being about equally upward and backward, and inclined at an angle of about 65° with the front of the lower surface; the front of the mesothorax in advance of the tubercle is nearly perpendicular, behind it nearly horizontal, but sloping slightly downward and a little convex; the first four segments of the abdomen are straight and horizontal, the succeeding ones curved regularly and roundly downward. Under surface in front of the base of the wings nearly straight, beyond, as far as the tip of the wings, considerably arched, but not quite regularly, being bent somewhat beyond the middle; the abdominal segments beyond are slightly concave, beneath tapering regularly as above; transversely the abdomen is strongly arched above, more strongly posteriorly than anteriorly, nearly flat beneath. Surface of the head flattened above, with a pair of minute rounded warts in the middle at the extreme base of the antennae; beneath flattened, a little prominent in the middle. Ocellar prominences pretty large, rugulose, especially the edges, trigonate-pyramidal, the edges carinate, divaricate but slightly, being nearly parallel, the front carina extending in a straight course to the junction of the tongue and antennae, and a little and rather suddenly prominent just below the middle; the inner carina irregular, scarcely receding, and more or less minutely notched on its apical half, suddenly receding on its basal half, with a minute tubercle at the base and the front of the head between narrow and somewhat broadly concave; the superior carina is pretty strongly rounded on the head and extends more or less distinctly to the hindmost portion of the prothorax. The prothorax is channeled along the middle line, the channel enlarging posteriorly, the sides pretty deeply hollowed posteriorly. Mesothorax quite tumid throughout, but particularly in front, furnished close to the front with a rather large, abrupt, subtrigonate, rugulose tubercle, directed forward and a little upward, scarcely tapering, rather broader than high, the anterior edge coarse, the posterior pair extending not very distinctly over the tumid mesothorax, diverging somewhat, nearly to the posterior border. The basal wing tubercles are rather broadly and not greatly prominent, surmounted by a rugulose, transverse, curving ridge, giving it a subtrigonate appearance; the ridge upon the side of the body is not very prominent, well rounded, following the upper edge of the wing as far as the third abdominal segment, beyond following the stigmatal line to the base of the fifth segment, where it terminates, being a little prominent on the posterior portion of the second and third segments; there is an indistinct laterodorsal ridge over the whole of the abdomen, made conspicuous by small, somewhat compressed, papillose tubercles, highest posteriorly, situated on the metathorax and the fourth to seventh abdominal segments, the first

and last smaller than the others, that of the metathorax not compressed; there is also a lateroventral ridge becoming conspicuous and even sharp posteriorly. Preanal button limited laterally by a pretty strongly impressed, curving line, in front terminating in a pair of closely approximated, very small, appressed, recumbent, rounded tubercles. Cremaster transversely quadrilateral, considerably broader beneath, its edge in continuation of the abdominal carinae, its sides flat or slightly hollowed, especially above; viewed from above, a little longer than its greatest breadth, tapering in regular continuation of the abdomen, abruptly and considerably truncate, the apex having the shape of the transverse cut, the field of anal hooklets transverse, twice as broad as long, ovate. Hooklets as in Euphœodes, but the lateral expansions of the apical cup are sharply pointed.

This genus, tolerably rich in species, is widely distributed over the northern hemisphere and represented in about equal numbers in the Old and New World. Like *Jasoniades*, but, I believe, unlike any other genus of swallow-tails, it is confined to temperate regions or to elevated parts of the tropics. In the north of the Old World, the limits of the genus, which stretch from ocean to ocean, are found between the Tropic of Cancer and 60° N. Lat.; that is, they comprise almost the whole north temperate zone. It also reappears beyond the tropics, in Australia. In the New World it occupies the whole northern continent, including the larger Antilles, excepting north of a line connecting the middle of Newfoundland with the mouth of the river Yukon in Alaska and extends southward over the western part of northern South America as far as the equator, although here probably limited to elevated country. A northern species nearly reaches the upper confines of New England, while another, which is widely spread over the continent, occurs throughout our territory.

The butterflies of this genus are among the smaller of swallow-tails and bear a moderately long, equal or tapering, never spatulate tail on either hind wing. The genus is peculiar among our native swallow-tails for the length of the fore tibiae and the nearly equal division of the hind legs of the female into femur, tibiae and tarsi. The upper surface of the wings is black, sometimes dusted with yellow scales and bears a marginal series of yellow spots, circular on the fore wing, lunate on the hind; crossing both wings is a series of more or less connected yellow spots, forming a narrower or broader band, always broader and further removed from the outer margin on the hind wing than on the front; the fore wing often has in the cell one or two transverse bars of varying width and the hind wing a bright colored ocellus at the anal angle; the apical half of the hind wing is also often dusted with blue scales. Beneath, the ground color is less intense and the markings of the upper surface are repeated, the yellow often changing to orange.

The insects are single, double or triple brooded, wintering either as chrysalids or butterflies. The eggs are laid singly and hatch in about a week, the larvae live singly and exposed on wild and cultivated Umbelliferae and the chrysalids, unless they hibernate, generally hang about a fortnight.

The butterflies have a wilder and more unsteady flight than those of *Iphiclides*. The European species is said by Meyer Dür to occur in Switzerland from the plains nearly to the height of 5000 feet; the southern species of the New World are probably confined to elevated regions.

The metamorphoses of several species are known. The eggs are nearly spherical and about a millimetre in diameter; the juvenile larvae are angulated, a little tumid on some of the anterior segments and covered with longitudinal series of warty tubercles beset with whorls of little bristles. They are nearly black, with a saddle of white across the middle, and this coloring continues through several moults, differing somewhat in different species.

The mature caterpillars are cylindrical and nearly equal throughout, slightly moniliform, naked, green, transversely striped with velvety black bands in which orange spots are arranged in regular longitudinal series, and they are thus very conspicuous objects; this livery is usually assumed with the fourth stage. The osmateria are perhaps smaller than in the other New England genera.

The chrysalids are generally greenish brown, more or less streaked with black, and are thus admirably concealed from view by their close resemblance to the dry bark of the twigs on which they may transform. In form they strongly resemble those of *Jasoniades*, although the caterpillars of the two genera are very different.

EXCURSUS LII.—THE LAW OF SUFFUSION IN BUTTERFLIES.

Wie der Schmetterling flattert um eine Blum'
Am zarten Kelch zu nippen,
So flatterte meine Seele stets
Um ihre Rosenlippen.

HEINE.—*Der Tannhäuser.*

ONCE in a while the collector in a well gleaned field is startled by capturing a butterfly with which he does not feel that he is acquainted. It has an uncanny look. He sees at once what it is like, that it is a *Vanessid* perhaps, or an *Argynnid*; but then he knows all these by heart, and this is surely none of them. "A variety," suggests his companion at the Entomological Club. Yes; but who ever saw such a variety, and of what? How blurred and streaked, too, it looks.

It does not often happen to a collector himself to meet these bizarre types in the field; but when found they are sure to be saved; and by degrees the collectors in one locality, by comparing notes, may discover that these sports occur in many species, and in the disturbance of their markings follow similar lines; in general these sports have been aptly termed suffusions, and it is the law of suffusion which we would here briefly notice. In

this way we may perhaps prevent the description of such forms as new and independent species, as has been done in no less than four instances with our own butterflies.

A little study of any one of these forms by an adept will quickly determine to what species it belongs, if the specimen be in sufficiently perfect condition to determine the structure of the minuter parts; for in doubtful cases, nowhere more than here, is such a careful examination of structural details essential as is uniformly insisted upon in the present work. This determined, comparisons with the typical distribution of the markings may be instituted. It will then be seen that in general the term suffusion is well chosen, though it does not cover all the elements involved. The disguise of suffusion is produced by the blending of certain colors, especially of black, white, or silvery tints, which are normally found at distinct parts of the wing; usually it occurs where there are two parallel or sub-parallel series of markings, following in general the same course as the outer margin of the wing; there may be, for example, two parallel series of white spots normally crossing the wing in the middle and near the border; under this disguise of suffusion, the whole intervening area, in the interspaces where the spots occur, is covered or shot with this color, generally more or less sprinkled with atoms of the normal ground, producing then an impure tint, and sometimes obliterating altogether any intervening markings of another character.

In the excursus on the origin of the diversity of ornamentation in butterflies (pp. 510-519) I have suggested that such parallel series of markings originated in a single marginal shade, and if the grounds for such an opinion are sound, we have, possibly, in these cases of suffusion, instances of reversion. This would sufficiently explain an otherwise puzzling fact that when these spots occur they take definite directions and repeat themselves over and over again. Both the strigate and the obsolescent types of suffusion may thus be brought under a common law, and where the suffusion is incomplete or imperfect, the different forms may readily be seen to be only relatively extended steps in a single direction. So far as I have seen, the suffusion shows no preference for the upper or under surface of the wings, or for one pair of wings.

It is, perhaps, due to the fact of the generally more complicated diversity of patterns in the highest family that we find this phenomenon relatively commoner among Nymphalidae than elsewhere. I have sought every possible example for description in the present work and run through many cabinets in the search for them, and the collection of instances here brought together is, I believe, the largest ever made anywhere, so that the following figures may not be without significance. We find examples of suffusion in thirteen of the forty Nymphalidae described in the body of this work, or, approximately, in one-third of the species; the numbers are both actually

and relatively less both in the *Lycaenidae* and *Papilionidae*, there being four in the former, or, approximately in one out of every five species, and three in the latter, or one in every five; while in the *Hesperiidae* there are but two instances brought to light, or only one for every twenty-three species. If we analyze the *Nymphalidae* more closely, we find the cases, with one exception, confined to the *Nymphalinae* and distributed as follows, mentioned in the order of their relative importance: *Argynnidi*, five out of eight species; *Melitaeidi*, three out of five species; and *Vanessidi*, four out of thirteen species.

Here it may be observed that the *Argynnidi* and *Melitaeidi*, in which the relative number far exceeds the others, are more than almost any other tribes of butterflies, characteristic of the temperate regions of the earth; and in entire keeping with this fact is another, that examples of suffusion are almost exclusively confined to the temperate zone; that this is not due to a more thorough search of temperate regions is clear, because from no quarter of the globe are butterflies more eagerly sought than from the tropics, and the suffusion of butterflies in temperate regions is sufficiently common to be now known in nearly one-fifth of our species; I have myself seen nearly fifty suffused examples of our common *Heodes hypophlaeas*.

These facts point to cool temperature as a cause for such phenomena, and this presumption is strengthened by the relatively frequent occurrence of suffused specimens in the Alps of Switzerland and in spring broods of butterflies. It would be well to note the day of capture and elevation of the locality in every known case of suffusion to see how fairly this conclusion may be held; and to learn at what period in the life of the insect the cold must be present to effect this result. In experiments of the application of cold to chrysalids, such suffusions have been artificially produced, and this would seem to point to this as the direct cause; but it may be that cold in the larval period, inducing lethargy and so insufficient nourishment, may be equally effective, for the late Mr. Elliot states (*Science*, ii:353) that insufficient food given to caterpillars of *Euvanessa antiopa* resulted in sports which varied decidedly in the direction of the completely suffused type *E. a. hygaeia*.

It may be convenient here to tabulate the species of our own fauna in which suffused varieties have been found:—

Nymphalidae: *Polygonia satyrus*, *Euvanessa antiopa*, *Aglais milberti*, *Vanessa cardui*; *Speyeria idalia*, *Argynnis cybele*, *A. atlantis*, *Brenthis myrina*, *B. bellona*; *Phyciodes tharos*, *Cinclidia harrisii*, *Euphydryas phaeton*; *Anosia plexippus*. *Lycaenidae*: *Incisalia irus*, *Thecla liparops*; *Cyaniris pseudargiolus*; *Heodes hypophlaeas*. *Papilionidae*: *Eurymus philodice*; *Euphroeades troilus*, *Papilio polyxenes*. *Hesperiidae*: *Epargyreus tityrus*; *Thymelicus mystic*.

PAPILIO POLYXENES.—The black swallow-tail.

[The black swallow-tail (Gosse); star-dotted papillon (Emmons); parsley butterfly (Emmons); Asterias butterfly (Harris); black swallow-tail butterfly (Maynard).]

Papilio polyxenes Fabr., Syst. entom., 444-445 (1775); —Jabl., Naturyst. Ins. schmett., II: 233-260, pl. 18, fig. 1 (1784); —Abb., Draw. Ins. Ga. Brit. Mus., VI: 6, figs. 12, 13; XVI: 19, pl. 76 (ca. 1800); —Gundl., Ent. Cub., I: 136-138 (1881); —Auriv., Lep. Mus. Lud. Ulr., 178 (1882).

Amaryssus polyxenes Seudd., Syst. rev. Amer. butt., 45 (1872).

Priniceps polyxenes Seudd., Butt., 304, figs. 31, 32, 190 (1881).

Eques trojanus troilus Drury, Ill. nat. hist., I: 22-23, pl. 11, figs. 3, 5 (1770).

Papilio troilus (pars) Cram., Pap. exot., III: 25-26, 176, pl. 207, fig. A (1782); —Jabl., Naturyst. Ins. schmett., II: 242-252, pl. 17, figs. 3-4 (1784); —Smith-Abb., Lep. Ins. Ga., I: 2, pl. 1 (1797); —Butl., Cat. Fabr. Lep., 249-250 (1809).

Papilio asterius Cram., Pap. exot., IV: 194-196, pl. 385, figs. C, D (1782); —Esp., Ausl. schmett., I: 47-49, 248-249, pl. 11, figs. 1-2, pl. 40 b, fig. 6 (1801); —Poey, Mem. Soc. econ. Hab., (2) II: 235 (1846); —Ménét., Catal. coll. entom. Acad., II: 99-100 (1857); —Streck., Cat. Amer. Macrolep., 71-72 (1878); —Gundl., Zeitschr. ges. naturw., III: 158 (1879).

Euphœodes asterius Hüb., Verz. schmett., 83 (1816).

Papilio asterias Fabr., Mant. Ins., II: 2

(1787); —Boisd.-LeC., Lép. amér. sept., 14-16, pl. 4, figs. 1-4 (1833); —Boisd., Spec. gén. Lép., I: 332-334 (1836); —Westw., Drury Exot. entom., I: 21-22, pl. 11, figs. 2, 3, 5 (1837); —Lucas, Lép. exot., 39-39, pl. 20, fig. sup. (1845); —D'Urb., Can. nat. geol., II: 220-223, figs. a, b, pl. 3, fig. 2-3 (1857); —Harr., Ins. Inj. veg., 3d ed., 263-266, pl. 4, figs. 4-7 (1862); Entom. corresp., 270-271 (1869); —Morr., Syn. Lep. N. Amer., 5, 6 (1862); —Linn., Proc. entom. soc. Philad., III: 51 (1864); —Feld., Spec. Lep. huc. descr., 27-75 (1864); —H. Edw., Pac. coast Lep., 10 (II: 4) (1873); —Pagenst., Verh. nat-med. ver. Heidelb., n. f., I: 87-89 (1874); —Saund., Rep. ent. soc. Ont., 1876: 37-38, fig. 8 (1877); —Dewitz, Arch. naturg., XLIV: 1-4, pl. 1, figs. 2-4 (1878); —French, Rep. Ins. Ill., VII: 137-138 (1878); —Butt. east. U. S., 80-93, figs. 14-16 (1886); —Middl., Rep. Ins. Ill., x: 74 (1881); —Coq., Ibid., 173 (1881); —Edw., Pap., III: pl. 1, figs. 1-3 (1883); —Fern., Butt. Me., 23-24 (1884); —Grub., Jen. zeitschr. naturw., XVII: 467-468, pl. 7, figs. 1-5 (1884); —Pap., IV: 84-85, pl. 1, figs. 1-5 (1884); —Tepp., Ent. amer., I: 186-187 (1886); —Mayn., Butt. N. E., 51, pl. 6, figs. 71, 71 a (1886).

Papilio nigrescens etc. Pet., Gazoph., I: 4, pl. 6, fig. 12 (1709).

Figured also by Glover, Ill. N. A. Lep., pl. 1, fig. 1 (5 figs.), pl. 26, figs. 5, 8 (ined.).

Report is that dame Venus on a day,
In spring when flowres doo clothe the fruitful ground,
Walking abroad with all her nymphes to play,
Bad her faire damzels flocking her around
To gather flowers, her forehead to array:
Emongst the rest a gentle Nymph was found,
Bright Astery, exceeding all the crewe
In courteous usage and unstained hewe.
Who being nimble jointed than the rest,
And more industrious, gathered more store
Of the fields honour, than the others best.

SPENSER.—*Mulopotmos*.

... clothing all the crumbling wall of stone,
The wild grapes show their purple globes of wine,
The butterflies hold carnival alone,
And brilliantly their iris colors shine,
In harvest time.

COLLIER.—*In Harvest Time*.

Imago (♂: 2, 3). Head covered with not very long, black hairs and a little shorter, yellowish brown, inconspicuous scales; at the back of the head, behind and outside of the antennae there is a small, triangular yellow spot, specked with black, and occasionally a few yellow scales at the summit of the eye; the eyes are edged narrowly behind, nearly to their summit, with pale yellowish, which is generally inconspicuous and often wanting. Antennae blackish brown above, the tips of the joints paler, blackish mahogany brown below, specked with exceedingly short, fine hairs, the club

velvety black. Palpi black, the sides of the basal and middle joints and the upper surface and tip of the terminal joint furnished with pale whitish yellow scales, not so long as the black ones which fringe the front, but which are sometimes confined to the basal joint. Tongue piceous.

Thorax black above, the patagia black; a small, longitudinal, bright yellow spot anteriorly, one on either side, just in front of the patagia, and just behind the similarly colored spots of the head; beneath black. Coxae covered with velvety black hairs; legs all black, femora with short, fine black hairs; tibiae and tarsi plumbeo-piceous; extremity of fore and middle femora and basal half of same tibiae occasionally with a few yellowish scales; foliate appendage of fore tibiae dark yellowish brown; spines blackish; spurs and claws dark reddish brown.

Wings above lustrous black, tinged almost imperceptibly with dark olivaceous. *Fore wings* with a submarginal row of eight roundish, nearly equal, bright straw yellow spots, one in each principal interspace, from one-half to one-third as broad as the interspace, distant from the border by a little more than half the width of an interspace (a little nearer on the lower portion of the wing), the lowermost double; parallel to this, and about midway between it and the lower outer angle of the cell is a transverse series of larger, similarly colored, wedge-shaped spots in the eight lower interspaces, the uppermost usually broken, the inner edges powdery, either very conspicuous and usually growing larger downward (δ), or, less conspicuous and usually growing smaller downward (ϕ); in the uppermost broad subcostal interspace there is a yellow spot, often inconspicuous, midway between the furcation and the outer limit of the spot in the succeeding interspace; and the costal nervures above it are occasionally streaked faintly with yellowish; the outer limit of the cell is also marked by a transverse patch of yellow scales crossing the whole of it, sometimes reduced to a delicate, nearly indistinguishable powdering; the central third of the space between the two transverse rows of spots is occasionally powdered delicately with bluish scales, more conspicuously below than above, and sometimes confined to the median interspaces; fringe black, interrupted rather broadly with slender yellow lunules in all the interspaces, more broadly below than above, the medio-submedian interspace with a double lunule. *Hind wings* with two similar transverse rows of yellow spots crossing the wing: the submarginal row composed of high, well-defined lunules, nearly as broad as the interspaces, and distant from the margin by fully half the width of an interspace, the innermost transverse, nearly linear, scarcely curved; the mesial row crosses the wing, either just beyond the extremity of the cell (ϕ), or, including the extremity in the middle of the band (δ); it is either broad and conspicuous, forming a belt, interrupted only by the black nervures, and especially those of the cell (δ); or, formed of detached spots, not so conspicuous as the submarginal row and often almost entirely wanting (ϕ); in the male the band is occasionally only a little broader than the submarginal lunules, and is then limited to the outside of the discoidal cell, but usually it is twice as broad, its interior border powdery, running straight or nearly so from the costal border, three-fifths the distance from the base, to the inner border at more than three-quarters the distance from the base; when it is confined to the parts outside of the cell, the border is of course farther removed from the base and is also curved, not straight; the exterior border is better defined and more irregular, composed, in the first two interspaces, starting from the costal border, of a bent line, whose general direction is parallel to the interior border, in the next three interspaces of a more or less sharply zigzag line, the general effect of which is a slightly prominent arch, and beyond by a slightly curving line, subparallel to but approaching the interior border; the space between these two cross-bands is filled, excepting always a stripe adjoining the bands, with a powdering of caerulean scales, more profuse basally than apically, sometimes mingled with a few yellow scales apically, either conspicuous and forming a continuous or nearly continuous belt (ϕ), or much less conspicuous, detached into spots and sometimes almost entirely wanting, especially on the upper half of the wing (δ); at the anal angle is a pretty large, nearly circular, reddish orange spot, its outer third or half pale yellowish, and having

a black pupil in the centre, of variable size; fringe black, interrupted very broadly in the interspaces with yellow lunules, which extend down either side of the tail, on the inner side nearly or quite half way to the tip.

Beneath slightly lighter than above, especially the base of the hind wings, which are delicately but decidedly suffused with a slight olivaceous tinge. The *fore wings* exhibit an exact repetition of the markings of the upper surface, excepting that the submarginal spots are slightly larger and a little paler, the independent spots and streaks are rather more distinct and extensive, and the extra-mesial row of spots, or at least the lower ones, are faintly or even considerably suffused with orange; in the female, these spots are nearly or quite as large and distinct as in the male, or much more so than on the upper surface; between the two rows of spots a few pale yellow scales are occasionally scattered in a delicate, feeble row; and in the uppermost broad subcostal interspace, directly over the uppermost spot of the extra-mesial row, a cluster of such scales may sometimes be seen. The same may be said of the *hind wings*, so far as the two rows of spots are concerned, with the following exceptions: the male and female are alike in the character and extent of the mesial row, the female bearing the same markings as the male; in the female, however, the interior border seldom extends within the outer limit of the cell, but there is usually a spot of greater or less magnitude in the cell, at the extremity; in both sexes these spots are bright orange, the summits of the upper row edged with pale yellow, and they are separated from each other a little more widely than on the upper surface; the spots of the submarginal row are scarcely lunular, but mostly transverse ovate, the upper four orange, edged laterally with pale yellow, the others pale yellow, occasionally tinged slightly in the centre with orange; the anal spot is the same as above; beyond the mesial row of spots is a narrow, nearly uniform band of velvety black, following the irregularities of the exterior border of the spots, and followed in each interspace by a powdery, transverse or subtriangular cluster of brilliant blue scales, which change beyond to those of a pale yellowish green color, scattered less profusely over nearly all the space intervening between the previous markings and the submarginal spots; occasionally, and especially in the male, there are scarcely more green than blue scales; fringe as on the upper surface but paler, and each lunule infringes slightly upon the wing itself.

Abdomen black, with a laterodorsal row of pretty large, round, straw yellow spots, one in the middle of each segment, largest in the middle, and decreasing in size toward either end and especially toward the base; a lateral row of similar but equal spots, and an infralateral row of smaller equal spots; the valves of the male dark brown (35:30), half as long again as broad, scarcely tumid, the lower border slightly sinuate, the upper strongly arched, the tip roundly angled; the armature consisting of a straight rod, half as long as the clasp and parallel with its lower border, turned upward at its extremity and supporting a thin, equal, straight and slender, horizontal lamina, bearing short, pointed, triangular, closely crowded denticles.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	39.5	51.	51.	38.	51.5	51.5
anterior.....	15.	18.5	18.5	14.	16.5	16.5
hind tibiae and tarsi.....	12.5	16.	16.	12.	15.	15.
fore tibiae and tarsi.....	9.75	12.5	12.5	9.5	11.75	11.75

Described from 13 ♂, 12 ♀.

Suffused aberrations. PAP. POLYXENES CALVERLYI (*Pap. calverlyi* Grote, Proc. ent. soc. Philad., 11: 441-442, pl. 10, —1864; —*Pap. var? calverlyi* Mead, Am. nat., 11: 332, —1869; —*P. asterias var. calverlyi* Edw., Butt. N. A., 11: Pap. xl, —1877. Figured also by Glover, Ill. N. A. Lep., pl. G, fig. 13, and on a separate unmarked plate, under the name *P. calverlyi*.)

Mr. A. R. Grote has described a suffused male of this species. I have not seen

the specimen, but judging from the figure and description there can be no doubt what it is. The aberration consists principally in an outward extension of the extra-mesial transverse series of yellow spots on all the wings above and beneath, quite up to and partially including the submarginal series, which, however, do not lose, upon the under surface of the fore wings, their distinctive color; on the fore wing, the color expands laterally by slow degrees, so as to occupy toward its outer limit the whole of each interspace, separated only by the black veins. On the under side of the fore wing the color is mostly similar to that of the upper surface but toward the inner border becomes bathed in orange. Mr. Grote does not mention, although his figure represents, the interior edging of yellow to the extended extra-mesial orange band of the under surface of the hind wings, just as we find it in normal specimens. In addition to this principal distinction, the yellowish edging of the tip of the cell of the fore wings above is lost (which is a little remarkable, as we should rather have expected to see the yellow markings extend to and embrace this also) as also most of the black and yellow on the upper surface and the black on the under surface of the incipient ocellus at the anal angle of the hind wings and which deprives it almost altogether of its ocellar like character. Of course, too, all the blue speckling of the hind wing is lost, since the place where it occurs is wholly bathed in the extension of the extra-mesial yellow band. On the under surface of the fore wings, the upper limit of the broad outer belt of yellow is indicated in normal males (always?) by the yellowish flecking of the subcostal nervures from the extra-mesial normal band nearly to the outer margin. According to Grote, the lateral series of yellow spots on the abdomen are altogether wanting and the subdorsal rows are represented of the ordinary size and in the usual position. This very peculiar and interesting feature has never before been observed, so far as I am aware, in suffused individuals, and I see no way of accounting for it.

An examination of the specimen from Florida, obtained and described by Mead, figured by Edwards, and now owned by Holland, shows that this peculiar insect is only an aberration of polyxenes through extensive suffusion. On the upper side of the fore wings the two rows of yellow spots have simply coalesced, forming longitudinal, fusiform spots, rounded at one end, clearly separated by nervules; toward the costal margin they include the innermost spots; the yellow spot at the tip of the cell is larger but does not otherwise differ from the type and the subcostal nervure beyond it is flecked with yellow; both the interior and exterior borders of the lower spots are tinged slightly with orange; this is especially true of the interior border. On the hind wings, there is a similar coalescence of the outer and inner spots, but several points may be noted: the outer row of spots is still distinct, being wholly yellow, while the suffused area is almost wholly orange; the interior border of the inner spots is more powdery and extends considerably further toward the base (especially in the costo-subcostal region) than in the type, all the outer half of the cell being powdered and the yellow extending even further toward the base above it; the blue powdering of the typical polyxenes is present but is inconspicuous upon the orange ground; the anal spot is normal, excepting that it is bordered with black only at the outer margin; the upper spot of the outer series is not touched with orange, as usually happens in the norm. Beneath, the fore wings resemble the upper surface; the hind wings differ from the upper surface of the same pair as one would anticipate; the two lower lunules of the outer row are yellow, while the others, being normally orange, can scarcely be separately distinguished; the limitation of the blue scales defines the margin of the inner row, which extends, as above, abnormally toward the base. The nervules are all edged with black, more broadly toward the outer margin of the wing, and where the blue scales come in contact with this black they are distinctly seen to be blue, but overlying the orange they appear very pale, almost white. On the body the three rows of spots are normal, excepting that on the terminal segments there is a tendency toward a suffusion of the spots on the same segment belonging to the two upper rows.

In the collection by Mr. Mead I once saw a female of this species in which the yellow markings were greatly reduced, an instance of partial melanism. The inner row of

spots upon the upper surface of both wings had almost entirely disappeared, with the exception of the uppermost and lowermost spots of the hind wings. Similar differences occurred beneath and even the blue markings of the under surface were greatly restricted.

In the same collection I saw a male bred in the Catskills in which the clasps were entirely aborted, although all the other parts were perfect.

Secondary sexual distinctions. Besides the differences in the distribution of the markings of the wings, detailed in the description above, see the generic description for differences in the neurulation (61: 15, 16).

Egg. (66: 2). Surface slightly glistening, covered with the most excessively fine granulations, which about the micropyle are rudely and very obscurely arranged in irregular polygonal cells about .025 mm. in diameter; the micropyle canals are two tubes .023 mm. long, on either side of the pole of the egg, inclined toward each other, and .05 mm. apart. When first laid, the interior of the egg appears to be filled with dark globular cells about .0125 mm. in diameter and separated by pale interspaces. The color of the egg is at first a pale honey yellow, afterwards changing in parts to reddish brown. Height, 1 mm.; breadth, 1.05 mm.; sometimes a little larger.

Caterpillar. *First stage* (72: 11). Head (79: 56) shining black. Body blackish brown, excepting a transverse yellow spot on the first thoracic segment between the lateral tubercles; also the greater part of the dorsum of the fourth and a portion of that of the third abdominal segments are whitish and there are sometimes occasional white spots on the segments anterior to them. The tubercles of the lateral and infrastigmatal series are dull orange, those of the lateral row on the third and fourth abdominal segments partaking of the color of these segments; their warts and all the other warts of the body as well as all the bristles and hairs, black. When just out of the egg, length, 2.4 mm.; when fully grown, length, 8 mm.; breadth anteriorly, 2.5 mm.; posteriorly, 1.75 mm.; width of head, .78 mm.

Second stage (76: 17). Head (79: 57) very pale yellow with a white streak down the middle of either half and enclosing the ocellar area which is orange; ocelli black. These at least are the colors when it first moults, but the head afterwards becomes wholly black. Body black excepting upon the dorsal surface of the third and fourth abdominal segments, which are white; excepting on these segments, where they partake of the color of the body, the tubercles are all orange with black spines, the central spine being longer than the others which form a corona around it. Length, 3.75 mm.

Third stage. Head (79: 58) mostly black, but with a white triangular spot in front, of about the size of the frontal triangle and partly superimposed upon it, its base being about half way up the latter; beside it are two similar ones of equal size, one upon either side. Body mostly jet black; delicate, transverse, white lines occur on the greater portion of the dorsal and most of the lateral region of the third and fourth abdominal segments and sometimes at either extremity of all the segments; a stigmatal row of bright lemon yellow spots, one to each segment, the base of all the tubercles bright lemon yellow. Length, 15 mm.

Fourth stage (76: 24). Head (79: 59) greenish white with two broad, black stripes down either side of the front, most of the hinder edge and the triangle black. Body faint greenish white marked with black in a manner to be described in the succeeding stage, but with proportionally rather broader belts and with insignificant irregularities of the border; in the place to be hereafter occupied by the hollowings of the margin of the belt are here found longitudinal laterodorsal and lateral rows of thorny tubercles, which are small, conical and black, bearing short needle-like spines; the former row becomes subdorsal on the thoracic segments, those of the first segment being situated directly behind the osmaterial orifice, while the lateral row becomes supralateral, occurring just at the extremity of the same orifice and a little in advance of the subdorsal pair; on the under side of the body inky black predominates; osmaterium pale orange at base, the forks pellucid. Length, .25 mm.; breadth, 5 mm.; length of osmaterium, 5.5 mm.

Last stage (76: 27). Head (79: 60) green with two broad stripes of black, one

on either side reaching from the apex to the outer edges of the labrum and two other similar ones extending from near the apex along the hinder edge of the head to the under surface but not meeting at either end; triangle excepting the edges, black; and between this and the first mentioned band the head is lemon yellow; ocellar field black; antennae white, dusky at tip. Body pea-green marked with black; every segment excepting the first thoracic is margined broadly at the anterior extremity with black, narrowing on the sides and seldom extending much upon the under surface; across the middle of all the segments, excepting those at the two extremities, is a broad, transverse, black belt, generally situated midway between two consecutive black margins and occupying above nearly half the space between them; on the eighth abdominal segment the belt is placed close to the posterior border; the anterior border of this belt is very irregular, little rounded, lemon colored pits, often more than half the depth of the band, being hollowed out along a laterodorsal and lateral line, the latter becoming supralateral on the thoracic segments; there are also similar but larger suprastigmatal pits, deeper than the others and hollowed out from the posterior border of the belt, with the lateral pits causing the lower portion of the belt to form a large S-shaped band; or broader than the others and hollowed like them from the anterior border, on the thoracic segments; on the abdominal segments the entrance of the latter pits is occasionally closed so as to leave a lemon colored spot in the centre of the black belt; the first thoracic segment has the central belt but it is entire and in front of the osmaterial orifice are three short, moderately broad, longitudinal bars, one median, the other at either extremity of the orifice; the anterior fold of the ninth abdominal segment is bordered posteriorly by a broad, transverse stripe, interrupted, at least in front, subdorsally; at the anterior limit of the portion behind is a transverse equal stripe, extending just beyond the limits of the laterodorsal line, and behind this is an inclined, transverse, irregular stripe, starting from close to the anterior base of the segment and crossing its most elevated hinder portion; there is also a ventro-stigmatal row of rather large, round, black spots, two each on the first to eighth abdominal segments, confluent on the seventh and eighth. Beneath, the body is greenish white with a ventral black spot in the middle of each segment. Body covered with exceedingly short, delicate, distant, black hairs. Osmaterium pale orange. Spiracles and legs of the color of the body, the basal joint of each with a large exterior spot of black, the other joints blackish exteriorly. Prolegs of the color of the under surface, the ventral pairs with a large black spot on the exterior of the basal joint; the anal pair with a black spot between the joints behind and having the terminal joint edged broadly with black, excepting behind. Length of body, 50 mm.; breadth of head, 4 mm.; breadth of body anteriorly, 8.5 mm.; common stem of osmaterium, 1.5 mm. long; the forks each 11 mm. long.

Chrysalis (85: 13, 18, 19). When it has first transformed it is a very light yellowish brown tinged slightly with greenish, especially on the thorax; the head and all the appendages are dark green with slight black streaks along some of the nervures of the wings; there is a narrow brown stigmatal band. The whole, however, gradually turns to a darker color, the green mostly disappears, excepting occasionally as a slight tint and in a day or two it has assumed its permanent colors as follows: Light dirty brown, the head and thorax and especially the wings of a hoary appearance, the base of some of the nervures of the wings traced in black. Antennae and tongue very dark green; legs dark brown, the mesothoracic tubercle and the upper surface as well as the upper portion of the sides of the ocellar prominences black; a broad, indistinct, dark brown, dorsal band on most of the abdominal segments, deepest in tint on the fourth to seventh segments; a dark brown stigmatal band broadest and of deepest tint on the same segments; and the posterior portion of the dorsal surface of each abdominal segment with a transverse interrupted black line; tubercles black. Length, 32 mm.; breadth at ocellar tubercles, 4.25 mm.; at thorax, 8 mm.; at abdomen, 9 mm.; height of thorax above general dorsal outline, 2.5 mm.; height of middle of the body, 9 mm.; breadth of tip of cremaster, 2 mm.; length of hooklets, .14 mm.; breadth of their apical cup, .05 mm.; of mass of hooklets longitudinally, .6 mm.; of mass of hooklets transversely, 1.2 mm.

Geographical distribution (27:3). This butterfly is wide-spread, occurring throughout the Canadian, Alleghanian and Carolinian faunas from the Atlantic to the Pacific, but is rarely found in the Rocky Mountain region, where it is largely supplanted by an allied species of the same genus. It extends throughout the peninsula of Florida and also penetrates as far south as Cuba (Gundlach) and Haiti (British Museum), but it has here evidently been introduced, since in Cuba it occurs only in the vicinity of Havana (Gundlach). Whether it extends into Mexico, as has been asserted, or the form found there should be referred to a closely allied species, is uncertain; but if it be regarded as a mere variety of our own form, the range of the species extends throughout Mexico to the hill country of Guatemala, possibly to Venezuela. Northward it is not found far beyond our own border, is curiously supplanted at the east by a short-tailed form found in Newfoundland, the Island of Anticosti and on the mainland of Labrador opposite the latter. It has not been reported even from the north shore of Lake Superior, although it is found at Quebec (Bowles), Montreal (Lyman, Caulfield) and is common in Wisconsin (Hoy). Farther west it has been collected as far north as the Heart River Crossing in Dakota (Allen) and even at Edmonton in the northwest territory of Canada (Geddes). On the Pacific coast, it is found in the vicinity of San Francisco (H. Edwards), and presumably, from general statements, along the entire coast. According to Mead, however, it occurs very rarely, and is also rare in Colorado and New Mexico.

It is pretty uniformly common throughout New England, although Gosse did not find it at a short distance from the border of Vermont, at Compton, Can.

Haunts. Cultivated fields or hilly pastures are the favorite haunts of this butterfly, which is particularly fond of flowers and of the moisture in the earth; it is therefore often seen upon highways at the damp spots in the ruts of the road or by the flowers that spring in the shrubbery which follows the walls or fences. It is found at all moderate elevations, in Colorado and other parts of the west not above 7500', according to Mead, and according to Dr. Bean it ascends the eastern slope of the Blue Ridge in North Carolina to a height of three thousand feet (Uhler). Of its occurrence in Georgia, Abbot says it "is most frequent in the lower parts."

Oviposition. The eggs are laid singly, usually, in my experience, on the upper surface of the finely cut leaves of umbelliferous plants, never more than one on a leaflet; but Miss Guild says she has always found them on the under surface, and others have said that many are often laid on adjoining leaflets so closely as almost to form a cluster. I have never seen anything like this, and think it only probable in confinement or some special circumstances; they are generally attached either to the midrib or

to one of the side veins, but sometimes are found on the surface of the leaf itself. The late Dr. Asa Fitch in his manuscripts says that July 27, 1858, he "noticed a female at mid-day hovering around some caraway, ovipositing. She gently settles on the end of a leaf, holding thereto with her feet for a few moments, whilst she curves her abdomen forward and places an egg upon the upper surface of one of the small leaflets, and then gently flies away to another leaf." Professor Hamlin once obtained six or eight eggs from a female after she had been impaled on a pin. The eggs hatch in from five to nine, generally from seven to nine days with us; in Cuba Dr. Gundlach has had them hatch in four days in midsummer.

Food plants. This caterpillar will probably eat any of our native, introduced or cultivated Umbelliferae, since it has been found upon a large number of them, among which may be specified: carrot (*Daucus carota* Linn.), marsh pennywort (*Hydrocotyle*), poison hemlock (*Conium maculatum* Linn.), water hemlock (*Cicuta maculata* Linn.), also *C. virosa* Linn. and *C. bulbifera* Linn., water parsley (*Sium cicutaeifolium* Gmel.), *Apium divaricatum*, celery (*Apium graveolens* Linn.), mock bishop weed (*Discopleura capillacea* DeC.), parsley (*Carum petroselinum*), caraway (*Carum carui* Linn.), dill (*Anethum graveolens*), fennel (*Foeniculum vulgare*), Archangelica, false water drop-wort (*Tiedemannia*) and parsnip (*Pastinaca sativa* Linn.). Dr. Chapman writes that in Florida the first brood feeds on *Apium divaricatum* because there is at that season no other umbelliferous plant for it to eat; at the appearance of the second brood *Apium* has disappeared and it must find some other; this he believes to be *Discopleura*, but he once saw a female laying eggs on *Hydrocotyle*, and Mrs. Treat has taken it on *H. umbellata* Linn. In September or October he met the full grown caterpillars on *Tiedemannia teretifolia*. *Cicuta maculata*, he adds, is abundant in the marshes, but he has never found the caterpillars upon it. According to Gollmer, the caterpillar (if it be really this species) feeds in Venezuela on *Arracia esculenta*. No one seems to have found the larva on anything but an umbelliferous plant, excepting Mr. Fletcher, who tells me that he has taken it on *Dictamnus fraxinella*, an introduced plant of the rue family.

Habits of the caterpillar. These caterpillars eat voraciously, especially during their last stage; yet even in the preceding stage Professor Hamlin observed one which doubled its length in a single morning, growing from half an inch to an inch in length and attaining a bulk ten times greater. They feed in plain view, and when wishing to moult, especially in the later stages, seem to mount to the outer surface of the plant to gain the fullest exposure, perhaps to avoid the danger of being rubbed at that time by the neighboring leaves moved by the wind, for they sometimes select the stems where they rest head upward. I have noticed the same habit in the European *P. machaon*, and both leave the cast-off skins untouched; changes of skin generally occur in the morning before ten o'clock.

The yellow osmateria are protruded at rather slight provocation, but rarely to their full length, unless roughly handled; they emit a moderately strong and disagreeable odor not very dissimilar to that of the bruised leaves of their food plant. Fitch remarks in his manuscript: "As it walks along the slender pedicels of the umbel it moves its head first to one side and then to the other of the stem, attaching a slender thread of silk which it spins from its mouth to the stem, to form a more secure foot-hold for its feet."

In Cuba, according to Dr. Gundlach, the caterpillars attain their growth in the remarkably short time of nine or ten days, the first moult taking place sometimes within thirty hours of birth. With us the larval period is often four weeks. Shortly before pupation, they discharge a great quantity of watery foecal matter and shrink notably in size, but they undergo scarcely any change of color. Mr. Riley calls my attention to the peculiar cup-shaped excrement.

Pupation. The caterpillar entangles the anal prolegs securely in a mat of silk, spins a loop in front, crawls underneath this and curves the head and front part of the body so that the head strikes the surface to which the ends of the loop were fastened and the cord passes between the second and third abdominal segments. It remains thus for at least twenty-four hours before the change to chrysalis is effected, when the thread sinks so deeply in the soft pupal skin as to be firmly embedded in it when dry; it passes across the back in the middle of the metathorax, and from its length allows considerable swing to the chrysalis. The chrysalis state varies with the season and latitude from nine to eighteen days; but Dr. Morris has stated that one instance was known to him of its duration for *two years and a half!* (Can. ent., xi: 201). A more complete statement with details should be given before full credence is given to it. The wood-browns of the chrysalis are evidently protective colors.

Life history. The history of this butterfly is somewhat different in the northern and southern states. In the south, judging principally from notes furnished by Dr. Chapman of Apalachicola, Fla., the butterfly hibernates, as Doubleday has stated, and lays eggs in the latter half of March and throughout most of April, at the end of which month the hibernating butterflies have disappeared. The eggs hatch in ten days, the caterpillars feed for three or four weeks, the chrysalids hang for from twelve to sixteen days and a first brood of fresh butterflies appears the last of April; a second brood, after remaining an equal time in chrysalis, appears in July, generally, it would seem, in the latter part of the month; and a third, the chrysalis state of which is shorter by several days, but which lasts in Cuba ten or eleven days, according to Gundlach, before the middle of September; fresh specimens continue to emerge from the chrysalis until nearly the end of October and these all hibernate. The perfect

insects may therefore be seen throughout the year, excepting in one or two winter months. Abbot, in Georgia, raised the butterfly on May 2, July 4 and August 27 after twelve, eleven and nine days in chrysalis.

In the north, on the other hand, the insect is double brooded and winters as a chrysalis. It appears on the wing in May, generally about the 21st, seldom before the 15th (though at this date I have found them common in central Connecticut, and once saw a male in Boston on May 10) occasionally as late as the last days of the month. In northern New England and corresponding latitudes it sometimes appears as late as the end of the first week of June; the female begins to lay eggs after the first week of June and continues to do so until the brood disappears early in July. Mr. Fletcher obtained eggs in Ottawa laid as late as July 23. The eggs hatch in eight or nine days, and the caterpillars become full grown between the 10th of July and the end of August, and, in from twenty to forty hours after the completion of the girth, slough their integuments and become chrysalids; the duration of this state seems to be quite variable, ranging from eight to eighteen days, but the average seems to be ten or eleven. The second brood generally appears a little after, occasionally shortly before, the middle of July and continues to emerge from the chrysalis until the end of August, and to fly until at least the middle of September; the eggs are laid during August and the caterpillar may be found full grown during the whole of September and occasionally during latter days of August; the chrysalids from these hibernate. The butterfly, therefore, generally be found from the middle of May to the middle of September.

Habits and flight of the butterfly. This butterfly is very fond of flowers, especially, says Doubleday, "of some of the thistles, as *Cnicus horridulus*, and of *Cephalanthus occidentalis*." It is said by R. M. Christy that it has been known to alight on faded leaf-patches of birch, "apparently mistaking them for flowers on account of the bright coloring." It is so fond of the flowers of verbena that complaint has been made to the Agricultural Department, Mr. Riley tells me, that flowers could at times scarcely be got, as the butterflies in withdrawing their tongues pulled them all to pieces! On the other hand its visits to flowers have been proved to be useful to the latter, as in one instance Prof. S. I. Smith took a specimen with a number of pollinia of an orchid, *Platanthera*, attached to its proboscis, so encumbered by them, indeed, that the maxillae could not be coiled up between the palpi. Maynard notes that they are particularly fond of red clover, and that when feeding they "keep the wings in constant, tremulous motion."

When on the wing they course about meadows and pastures, taking first one direction, then another, frequently half doubling on their course and so returning at last to the same place they have repeatedly visited. They ordinarily fly not more than a foot above the herbage or indeed above the ground

in a well cropped pasture. The wings are flapped up and down in regular beats which are tolerably short, the extremes of upward and downward motion forming only an angle of about 90°. When alarmed, however, they go at great speed, zigzagging rapidly, with occasional upward and downward starts thrown in, kept up even when the pursuer or the moving object which caused the fright may be far in the rear. Or, as De Garmo has said, they will then "make a detour, alighting briefly on some other flower or leaf, and then almost invariably return to the one from which they were frightened." Mr. D'Urban well remarks that polyxenes is "not so strong a flier" as *Jasoniades glaucus*, and is much more easily captured.

Miscellaneous. Dr. Packard made the experiment of removing the antennae of this butterfly (Am. nat., xi: 420-421):—

It flew irregularly to the floor, remaining there; on opening the window it flew out heavily, having evidently lost some of its powers of flight and of directing the movements of its wings. It remained just where it had settled in the path from four p.m. until nine o'clock the next morning. Then on putting it in a sunny place it disappeared five minutes after, and must have become warmed and flown away.

Mr. Uhler states that he has observed the union of this species and *E. glaucus* when in close proximity to him; and adds that Dr. Melsheimer had several times observed the same phenomenon. No hybrids are known.

Mr. Edwards possesses an hermaphrodite specimen, the right wings male, the left female, distinctly marked upon both surfaces with no suffusion of color. It was taken by Mr. Meyer.

Enemies. The caterpillar, and apparently that of the second brood in particular, is attacked by *Trogus exesorius* Brullé (88:3); no one who has attempted to rear this insect has failed to find it out. The parasites which attack this second brood escape from the chrysalis in April or May of the following year; those which infest the first brood of caterpillars appear again as imagoes in August and September, escaping from chrysalids which have hung from three to four weeks; occasionally one of them may not emerge until the succeeding spring; they escape by cutting a large, nearly circular hole through one of the wing-cases. Mr. Riley has also bred *Trogus obsidianator* Brullé from a chrysalis found in Washington and both he and Mrs. Treat have obtained *Apanteles lunatus* from the caterpillar. Riley also discovered an unknown hemipterous insect busily sucking the eggs of the second brood. And finally, Dr. Hagen saw the large dragon fly, *Anax longipes*, preying upon the butterflies in southern Massachusetts, catching them and then settling on a shrub to behead and devour them.

Desiderata. A description of the postures of the butterfly and the determination of the duration of the egg in August are the principal lacunae in our knowledge of this species in the north. Are the eggs generally laid on the upper or under surfaces of leaves? Are they ever naturally laid in loose clusters? Do the August chrysalids ever normally give birth to

butterflies in the north? And if so, what then becomes of the butterfly?
Is the caterpillar refused by all birds? At about what latitude or isotherm
does the change from two to three broods take place?

LIST OF ILLUSTRATIONS.—*PAPILIO POLYXENES*.

General.

Pl. 27, fig. 3. Distribution in North America.

88: 3. *Trogus exesorius*, a parasite.

Egg.

Pl. 66, fig. 2. Outline.

Caterpillar.

Pl. 72, fig. 11. Caterpillar at birth.

76: 17. In second stage.

24. In fourth stage.

27. Mature caterpillar.

79: 56-60. Front view of head, stages I-V.

Chrysalis.

Pl. 85, fig. 13. Colored.

18, 19. Outlines.

Imago.

Pl. 8, fig. 2. Female, upper surface.

3. Male, both surfaces.

35: 30. Male abdominal appendages.

40: 1. Neuration.

37: 2. Side view, with head and appendages enlarged, and details of leg structure.

61: 15, 16. Neuration of the fore wing, ♂, ♀

IV.

FAMILY HESPERIDAE.

SKIPPER.

Plebeii urbicolae Linné.
Urbicolae Fabr.; Urbicoles Walek.
Rustici Herbst.

Hesperiae Lam.; Hesperides Latr.; Hesperidae Leach; Hesperiaedes Billb.; Hesperidi Boisd.; Hesperites Newm.; Hesperiidæ Westw.; Hesperistica Grav.; Hesperiolidae Wallengr.; Hesperii Luc.; Hesperiadæ

Gerst.; Hesperidina Herr.-Schaeff.; Hesperilina Plötz.
Astyei Hübner.
Anopluriform stirps Horsfield.
Involuti Boisdual.
Microptères Rambur.
Celantes Newman.
Quadricarati Guenée.

Swift Redouins of the pathless air,
Finding rich plunder everywhere.

H. H.—*My House not made with Hands.*

Before thee stands this fair Hesperides,
With golden fruit, but dangerous to be touch'd.

SHAKESPEARE.—*Pericles.*

Imago. Of medium or small size, usually robust. Head very large, and especially very broad. Front quite full, at least twice as broad as high, occupying only the uppermost part of the anterior portion of the head and less than half of the summit, the lower outer angles docked a little, separated from the occiput by a slender furrow. Vertex largely developed at the expense of the other parts but not protuberant, occupying more than half the summit and very broad, encroaching on the occiput, which is less developed than usual; tongue inserted opposite the middle of the eyes or even higher; eyes prominent, always naked, usually overhung by a curving pencil of bristly hairs springing from just outside the base of the antennae, the cornea occupying almost the entire ocellar globe; antennae widely separated,—by from two to four times the width of their base,—not infringing on the eyes, the base consisting of two joints, forming together a nearly hemispherical foundation for the stalk, which is scarcely a fourth as broad as the base, its first joint, or the third of the club, many times longer than the next or than broad, the club almost invariably elongated, its apical joints diminishing rapidly in size and almost always forming a more or less reversed crook. Labial palpi very stout and compact, the first and second joints tumid, the apical far slenderer and usually small or linear, porrect, while the others hug the face and are densely scaled in an angular, generally trigonate setting.

Prothoracic lobes pretty small, strongly appressed, lamellate. Thorax stout, the upper surface somewhat arched. Middle of front of mesoscutellum projecting forward rectangularly between the sides of the mesoscuta, its sides also thrust forward below, its rounded, tumid posterior margin completely overshadowing the small metascutellum, which is formed of a wholly vertical, triangular, appressed plate; metascuta large, triangular, tumid, facing altogether laterally and scarcely seen from above; all the sutures deeply impressed, and the metathorax conspicuously separated from the mesothorax.

Wings generally of simple form, in particular the fore wings; these are triangular, the outer margin always gently arcuate and entire; costal margin terminating near or not far beyond the middle of the nearly straight costal margin; subcostal nervure with four superior branches and one inferior branch, itself terminating just below the tip of the wing; all of these originate in the apical half of the cell and fill the apical half of the costal margin with nearly equidistant, closely approximated, oblique veins; discoidal cell long and narrow, closed only by a very delicate vein, often marked only by a spur or the angle of the inferior subcostal nervure above; median nervure with four branches, the first almost always thrown off far before the middle of the cell, the last forming an independent vein, the extremity of the nervure proper, between the base of the two last nervules, being obsolete and marked only by a short spur or the angulation of the attachment of the penultimate nervule; internal nervure always present, very short, often obsolescent and usually bending up to and terminating in the submedian nervure. Hind wings rounded, triangular, the outer margin usually entire, sometimes crenulate or erose, sometimes with a broad and equal tail of greater or less length, formed always by the extension of the submedian nervure; or often angled or lobed at the same point; extreme base of costal margin with a fringe of stout, bristly hairs; the costal and subcostal nervures originate together and part at a short distance from the base, often enclosing between them a minute areole, and the subcostal at its more abruptly changed course appearing like an offshoot of the costal; it forks but once, near the middle of the wing; the discoidal cell is open or closed in part only by a spur, often merely indicated by an angulation of the opposing veins near the middle of the wing; the median nervure forks twice not far apart and near the middle of the wing; the internal is nearly as long as the submedian nervure excepting when the latter supports a tail or a lobe; inner margin of wing always plaited.

Fore legs differing from the others in that the tibiae have a foliate epiphysis on the inner side; the hind tibiae also have a post median as well as an apical pair of spurs, though these are sometimes absent; claws overhung by two pair of long, curving bristles.

Upper organ of the male abdominal appendages with a broad centrum and an unusual development of the parts beyond, and of the lateral arms, the hook-like posterior projection almost invariably double, occasionally consolidated, the whole piece generally elevated considerably above the claspers, so as never to be concealed by them. Claspers heavy, of very variable shape, generally developing spinous lobes at the extremity and in the middle of the upper border.

Egg. Compact, in a general way subglobular or hemispherical, the height not exceeding the diameter, the base squarely truncate, its rim a little curved, the sides rounded, the summit broadly rounded and usually flat at the extreme pole, the sides either longitudinally ribbed and then almost invariably supplied with numerous delicate cross lines, or else broken up into numerous inconspicuous angular cells.

Caterpillar at birth. Head globose, larger, generally conspicuously larger, than the thoracic segments, the first thoracic segment with a thickened dorsal shield, the body uniformly cylindrical, furnished with longitudinal series of minute papillae, supporting short, straight, apically enlarged bristles, not more than one or two to a segment in each row, never clustered. Often (or always?) also furnished with longitudinally arranged series of chitinous annuli of a minute size.

Mature caterpillar. Head large, completely free, generally rugose and pilose, and furnished posteriorly with a collar-like ring of greater or less length, not found in any other family, making a constricted neck. Body subcylindrical, tapering toward either extremity, ventrally flattened to a greater or less extent, never moniliform, the segments distinctly sectioned, furnished with numerous minute papillae, each supporting a short hair; on the shorter sections these have a somewhat regular transverse arrangement; there are also in many (all?) cases ranged series of minute chitinous annuli; the first thoracic segment has a corneous, dorsal, transverse shield, covering nearly the whole segment; spiracle of eighth abdominal segment larger than the other abdominal spiracles and out of line with them. Legs and prolegs short.

Chrysalis. Very simple and rounded, like those of moths, bluntly rounded in every sense in front, with scarcely prominent basal wing tubercles, the head nearly or quite as broad as the thorax, behind conical, the fifth to seventh abdominal segments more freely movable than the others, and often with an encircling ridge. No ocellar prominences, but occasionally a slender median frontal projection or horn; prothoracic spiracles large, often protuberant, guarded by a dense mat of conical pointed filaments. Head with a transverse suture between the antennae posteriorly, marking the line of parting when the butterfly escapes. Cremaster slender, protuberant, depressed, the hooklets placed at tip, exceedingly long and slender, their apical half considerably curved, the terminal portion thickened and curved much as in Nymphalidae.

This numerous but neglected family of butterflies is well represented in New England, comprising about one-third of our butterfly fauna. Indeed, the New World in general is far more richly endowed with this lowest type of butterflies than the Old, its metropolis being tropical America, where the species are excessively numerous. The whole northern continent appears to profit by this excess, for the family takes the place in our butterfly fauna which the Satyrinae do in Europe. The Hesperidae, however, are represented in nearly every part of the world where butterflies are found, even in the far north.

The insects of this group are inconspicuous, generally sombre in appearance and very uniform in structure among themselves, whether the egg, caterpillar, chrysalis or imago is considered; they differ, also, so considerably from all other butterflies that they are readily recognized and have very frequently been placed as a group of equal value to all other butterflies combined; but this has resulted from the consideration not of the character but of the number of the differences which separate them. Their whole body is generally very robust, and the head always broad; the antennae widely separated at their base and curved or crooked at the tip; the eyes large, naked and prominent, overhung by a little tuft of curving bristles; the palpi almost always short (although not as in most Papilioninae) with the middle joint greatly swollen and the last very small. Between the head and thorax is a thin cushion of large, erect scales; the wings are much smaller in proportion to the bulk of the body than in other butterflies, the front pair generally pointed, strong-veined, with peculiar venation, the inner margin of the hind pair always folded; the legs are perfect in both sexes; the fore tibiae furnished with an epiphysis, the hind pair almost invariably with a double instead of a single pair of spurs. They are of small, or at best of but moderate size, generally with dull colors in which dark brown and tawny predominate, and are often marked with vitreous spots, which are more frequently angular than as in most other butterflies round. The males are often provided with external signs of their sex in a costal fold on the fore wings, filled with downy hairs, or in velvety dashes on the same pair, in the latter case frequently accompanied by large and partially erect scales; sometimes the sexes also differ in the form of the antennae, and particularly of the crook of the club.

The caterpillars are easily distinguishable by the great constriction of the neck enveloped in a chitinous collar (a posterior extension of the hinder face of the skull) and by a corneous plate on the summit of the first thoracic segment. The head is almost invariably rugose, and the body smooth or covered with a very delicate pile composed of short hairs, which, at least in the first stage of the caterpillar, are always greatly enlarged at the extremity, so as to appear fungiform or wine-glass shaped. Neither head nor body is ever provided with spines, though in some tropical forms (*Pyrrhopyga*) the body is covered with long hairs; it is further noticeable that head and body are almost invariably of very distinct, sometimes almost incongruous colors, and that when the head is ornamented it is usually in large patches. The caterpillars live singly in nests formed of the leaves of their food plant, fastened by a few silken cords, and are very cleanly in their habits. They are also very slow in their every movement; it generally takes them nearly a day to eat their way out of their egg shells, and they appear to spend the major part of their lives within their nests, when it is horizontal resting feet upward, as if longing for the time when they could sleep the pupal sleep in that position.

In the change to imago, the chrysalis skin does not part at the suture between the head and prothorax so as to free the head, as is the case with all other butterflies, but in a special suture near the back of the head, running from one antenna to the other, so that a short marginal piece of the head remains attached to the prothorax in exuviation. This suture is plainly seen in the chrysalis of the Pamphilidi, but is generally obscure, though no less effectual in the Hesperidi.

The chrysalids are generally well rounded, presenting no prominences, excepting sometimes a slight projection in front, similar to that of the Pierinae. Poulton is evidently unfamiliar with the transformations of the Hesperidae, when, apropos of Weismann's remark that it is impossible to characterize the larvae of butterflies as a whole, as it is possible with the imagines, he says: "The pupae of *Rhopalocera* can be formed into a large group corresponding to the union of the imagines into one of the two chief divisions of *Lepidoptera*. The characters by which these pupae can be identified *as a whole* are bright, or at any rate varied, colours; angularity of outline, especially anteriorly; and mode of suspension. The divergence from the pupae of *Heterocera as a whole* is also accompanied by a difference in conditions; the latter being protected from light in the earth or in cocoons, while the former are freely exposed to it."

Werneburg remarks that the pupae of this group are darker or lighter according to the amount of exposure, those of the Hesperidi which pupate within leaves being dusky, while those of the Pamphilidi changing between grass blades are greenish.

The insects enclose themselves in a slight cocoon for transformation,

composed generally of leaves connected by silken bands and lined very delicately with silk; sometimes they make use of the nest in which they have previously lived. Within this they are attached both by their hinder extremity and by a sling for their body, the latter of which sometimes, perhaps always, takes the form of the letter Y; the same is sometimes true of the anal attachment in many cases, but the Y is often obscured by the mass of additional silk used in the same region. This cocoon-like mode of transformation, which is a strong proof of the affinity of these insects to the lower Lepidoptera, occurs in the higher groups in only two or three instances, confined to the two subfamilies of Papilionidae and has gained for the present group the name of *Involuti*. According to Forsayeth (*Trans. ent. soc. Lond.*, 1884, 387), "*Pamphila mathias*" makes no cocoon whatever, the chrysalids lying "along a blade of grass attached by a band across thorax and also at tail."

The butterflies are no less distinguished by their peculiar flight, which is extremely rapid, varied and interrupted, terminating suddenly after a short career and as suddenly resumed; as Lang expresses it, it is hurried and intermittent, never steady or sailing like that of other groups.

They almost invariably delight in the hottest sunshine, and generally frequent open meadows: many of them rest with their wings oddly spread, the front pair being more elevated than the hind pair, a feature which caused the French naturalist Geoffroy to apply to them the name of *estrophies*, while the vulgar English name, *skippers*, as aptly refers to their peculiar flight.

These insects, says Swainson, "have neither size nor brilliancy to recommend them, while their long, abruptly hooked antennae give them such an isolated character, that the family can never be mistaken."

Nor are their distinguishing characters confined to outward structure. Their flight is even more rapid than that of the *Nymphalidae*, and in the more typical species is performed with such celerity that the eye can scarcely follow the insect. They may, indeed, be compared to the... swallow tribe among birds... while their palpable affinity to the hawk-moths has induced almost every writer to place them as the connecting link between the diurnal and crepuscular Lepidoptera... [They] are conspicuous for the great thickness of their head and thorax, no less than for muscular strength: many fly in the same manner as the common humming-bird hawk-moth of Europe, and are most active during the morning and evening, resting with their wings erect; others prefer the meridian heat, and repose with all the four wings expanded; others, again, are never seen to take nourishment, but are found in the forests, sheltered under leaves; there is, in short, such a great diversity of habit in this family that it cannot be defined in precise terms; but in all, as showing their immediate connection to the hawk-moths, the eyes are remarkably large and prominent; this affinity is further manifested by the feet, palpi etc. (*Hist. Ins.*, 97, 99).

Wallace, in speaking of the *Hesperidae* of the Amazons (*Trans. ent. soc. Lond.*, [2] ii: 263-4), well remarks that there are three distinct

modes in which the wings are carried in repose: first, they are closed and carried erect as in the typical butterflies; second, the fore wings are elevated while the hind ones

expand; third, the wings are all expanded. The great majority of the South American species belong to the first of these divisions such as *Pyrrhopyga*, *Erycides*, *Gonlurus*, *Goniloba* and some species of *Pamphila* [corresponding in general to the higher Hesperidi]. To the second very few South American Hesperidae belong, principally of the genus *Pamphila* [corresponding to the Pamphilidi]. The third comprehends a very peculiar group of insects consisting of the genera *Pyrgus*, *Nisoniades* and *Achlyodes* [corresponding to the lower Hesperidi]. They have the upper wings more or less convex and never erect them in repose* and they will, I believe, form a very natural subdivision of the family.

They generally develop slowly, frequently having but a single generation in the course of the year†; very frequently (perhaps generally?) they hibernate in the chrysalis state, but there are a considerable number, which, though full grown in the autumn, do not change at this epoch, but, remaining dormant through the winter, undergo their transformations in the early spring before vegetation has started. None are certainly known to pass the winter either in the egg or the imago state.

A single species of each division of the family has been found fossil in the tertiary of Europe, one in the oligocene of Provence, and the other in the more recent deposits on the Rhine.

The division of the family. The classification of the Hesperidae has proved a stumbling-block to all who have proposed any arrangement of butterflies. Until recently no author, Hübner excepted, has even attempted more than a generic collocation,‡ and most essays of the latter sort have been exceedingly unsatisfactory. In his *Verzeichniss bekannter schmetterlinge*, Hübner divided the "stirps" into eight "families"; the first three of these are founded mainly on the form of the wings, the others simply on their markings; these divisions are almost wholly unnatural, although the sequence of the genera is far more reasonable than that of Herrich-Schaeffer or of Butler.

Fabricius was the first to separate the family into distinct genera. In Illiger's Magazine he divided it into three genera—*Thymeles*, *Helias* and *Pamphila*. *Helias* was founded upon a single, undescribed and now unknown species. If we omit *Helias*, the genera *Thymeles* and *Pamphila* will represent in the main§ the natural separation of the Hesperidae into two grand divisions, which are of less value than subfamilies, and may therefore be termed tribes; to the former we may apply the name Hesperidi, and to the latter Pamphilidi. The following distinctions will be found between the two tribes:—

* This is not strictly true either of European or North American species of these groups.

† Duponchel (*Inconogr. des chenilles*, 211) remarks of the European Hesperidae that the species with tawny ground color are single brooded, while those having a dark ground spotted with white are double brooded; but not only can this statement not be extended beyond Europe, but it is not even true there, many

Hesperidi being single brooded while the species of *Erynnis* and *Augiades* are double brooded.

‡ Latreille in the *Encyclopédie méthodique* separated the species into unnamed groups by an analytical table, based principally on the form and markings of the wings.

§ Some species enumerated under *Pamphila* belong to the first division.

In the Hesperidi, the fore wing of the male is always or almost always provided with a costal fold where a sort of silky down is concealed; this feature is often very inconspicuous; in the Pamphilidi, on the other hand, the male is generally furnished with a discal patch of peculiar scales crossing the median interspaces of the fore wings, usually in an oblique direction; but sometimes the wing of the male is as simple as that of the female. In the male Hesperidi again, the posterior extremity of the alimentary canal is protected beneath by a corneous sheath, which extends beyond the centrum or body of the upper pair of abdominal appendages, sometimes nearly to the extremity of the appendages, carrying the vent beyond the centrum; while in the Pamphilidi, the extremity of the canal is not protected by any extruded sheath, but opens at the very base of the inferior wall of the centrum.

In the Hesperidi, the prevailing color of the butterflies is dark brown, marked with white or translucent angular spots; the antennae generally have a long club roundly bent or with a sinuous lateral curve; in the Pamphilidi the prevailing tints of the wings are tawny and black, marked also, but often feebly, with pale, sometimes vitreous spots; the antennae are provided with a stout club, which generally tapers rapidly and terminates in a slender prolongation, recurved at about a right angle; but in a few genera the crook is very slight, or wholly wanting.

The body of the Hesperidi is proportionally stouter than in the Pamphilidi and their flight is generally swifter and more direct, although in some genera the movement is unusually slow. In the higher Hesperidi, when the insect is at rest, all the wings are held equally erect; in the lower groups, the wings are either perfectly or almost perfectly expanded, or else they present the inequality of position characteristic of the Pamphilidi, where the hind wings are usually horizontal or partially raised, while the fore wings are vertical, or oblique.

The earlier stages seem to present no peculiar distinctions, if we except the eggs; in the Hesperidi these are always distinctly ribbed vertically, as well as cross-lined, and are almost always about as tall as broad; while in the Pamphilidi the eggs are smooth and pretty regularly hemispherical, usually much broader than high; in some of the highest, the eggs are faintly ribbed vertically. The caterpillars of Hesperidi generally feed upon leguminous plants, or, if not, upon other angiosperms, and live in horizontal nests made of leaves; the Pamphilidi feed mostly on Gramineae, or other endogenous plants, and generally construct vertical nests among the blades.

This division of the family was proposed by me in 1874 (Bull. Buff. soc. nat. sc., i: 195-196), and has since received a certain amount of support, some writers accepting the arrangement though not adopting the divisions. Mabille in his arrangement of the Hesperidae of the Bruxelles Museum has even gone further and subdivided each of these tribes into

three or four minor groups of genera, which, so far as the Hesperidi are concerned, are, I think, of value. In the same year (1878) Burmeister, not willing to accept the divisions proposed on the ground that they were founded upon the male sex, which was certainly only partially true, proposed (Descr. phys. Rép. Arg., Lép., 245) a new division into four tribes—Pyrgidae, Achlyodidae (=Mabille's Antigonini), Thymelidae and Thamyrididae (=Mabille's Pyrrhopygini). His Pyrgidae and Thymelidae, however, are assemblages of extremely dissimilar material having no distinctive bonds in common, the former by the inclusion of the species he refers to *Pyrgus*, the latter by a medley of forms belonging to two or three of Mabille's divisions.* The latest division, that of Distant, is even more unfortunate, for his separation of the Malayan species into two groups, *Ismenaria* and *Erionotaria*, is based entirely on the relative length and breadth of the hind wings, a separation he does not claim as natural, and which seems to me, therefore, purely an obstacle, obliging him to separate allied and place near together dissimilar forms.

Since the publication of my proposed division I have not been able to give to this family, outside of the North American forms, the study I had hoped to do before publishing this work, but from numerous examinations and dissections made, from the criticisms and comments of others, and from the study of the published material upon the earlier stages, I have been brought to the conclusion that while it is possible that the distinctions to which I have drawn attention may not pervade the whole family, there is no question at all of their value as separating all the forms found in north temperate regions, and the fuller distinctions we have given in this work will, we think, warrant our conclusion. The characteristics of the larva, the chrysalis and the imago of the Pyrrhopygini of Mabille seem to me to indicate that they perhaps should form a distinct group equivalent to the Hesperidi rather than to either of the groups of genera into which the latter falls; while the lack of information concerning the early stages of so many tropical types leaves us in great uncertainty regarding the necessity for the further division of the Pamphilidi or the removal of a part of its members as distinct tribes; so far, however, as I have yet been able to obtain any information concerning the early stages, I discover nothing which seems to point to their further division into anything more important than groups of genera, such as those into which each of the two tribes is divided in the present work.

Table of tribes of Hesperidae, based on the egg.

Eggs vertically ribbed, the ribs connected by horizontal cross lines.....**Hesperidi.**
Eggs having the surface smooth or obscurely reticulated, with no sign of ribst...**Pamphilidi.**

* For instance, *Hylephila phylæus* and *Pyrgus americanus* are placed under Pyrgidae, *Thymelicus brettus* and *Eudamus proteus* under Thymelidae.

† The European *Heteropterus morpheus*,

however, has, as Goossens states, a vertically ribbed egg, but it is not cross lined, nor is it reticulate, but simply punctate; and the same is true in Pamphila, only the ribs are very obscure.

Table of tribes, based on the caterpillar at birth.

- Last abdominal segment furnished with simple, outward or posteriorly directed bristles, only a little longer than the others..... **Hesperidi.**
 Last segment furnished apically with some exceptionally long, recurved bristles. . **Pamphilidi.**

Table of tribes, based on the mature caterpillar.

- Upper half of head as seen from in front rounded or quadrangular; highest points of the two hemispheres more distant than the base of the frontal triangle. Body comparatively stout and plump..... **Hesperidi.**
 Upper half of head as seen from in front rapidly narrowing and subconical above, with the breadth of the base giving the whole head a triangular or pyramidal aspect; highest points of the two hemispheres no farther apart than the base of the frontal triangle. Body very elongated..... **Pamphilidi.**

Table of tribes, based on the chrysalis.

- Tongue case not extending beyond the tip of the wing-cases..... **Hesperidi.**
 Tongue case free at tip, extending beyond, generally much beyond, sometimes far beyond, the tip of the wing-cases..... **Pamphilidi.**

Table of tribes, based on the imago.

- Distal recurved part of antennal club as long or nearly as long as the proximal part, the club being bent where thickest; abdomen generally shorter than the hind wings. Males generally (in our species always) with a recurved fold of the fore wings containing androconia; extremity of the alimentary canal in males extended and protected beneath by a corneous sheath. Colors generally black or dark brown with white or vitreous, angular spots.... **Hesperidi.**
 Distal recurved part of antennal club either (occasionally) wholly wanting, or brief as compared to proximal part, the club being bent beyond where thickest; abdomen as long as or surpassing the hind wings. Males often (in our species usually) with a black, velvety patch across the disk of the fore wings containing androconia; extremity of alimentary canal in males not extended. Colors generally tawny and dark brown, sometimes with minute, vitreous spots..... **Pamphilidi.**

TRIBE HESPERIDI.

Hesperides (pars) Latreille.

Celebres + Fortes + Formales + Veteres + Vulgares + Cauti Hübner.

Pyrgidae (pars) + Achlyodidae + Thymelidae (pars) Burmeister.

Eudamini + Antigoniini Mabille.

Ich möchte gern mich frei bewahren,
 Verbergen vor der ganzen Welt,
 Auf stillen Flüssen möcht' ich fahren,
 Bedeckt von schatt'gen Wolkenzelt.
 Von Sommervögeln übergaukelt,
 Der ird'schen Schwere mich entziehn,
 Vom reinen Element geschaukelt,
 Die schuldbeleckten Menschen flehn.

PLATEN.

Imago. Generally of medium size, relatively stout. Antennae with the club usually long and slender, bent in the middle, the apical portion usually long drawn out, or with a sinuous lateral curve. Costal margin of fore wings generally more arcuate than in Pamphilidi, almost always furnished in the male with a reflexed fold, containing androconia concealed within, never with any discal patch of peculiar scales. Scales contained in this costal fold consisting of a very great variety, and differing: on the costal vein, where they are usually more or less scaphiform; in the area next below it, where they are similar, but very much smaller and less dense; followed by a field, generally a narrower one, next the tip of the opening of the fold, where they are very slender and elongate, often enlarged at one or the other extremity, sometimes

twisted or broken into joints or links; or there may be very slender stiff bristles, or slenderer hairs, or these are flagellate at the extremity with a very fine thread; cell of same wing usually more than two-thirds as long as the wing; hind wings sometimes tailed or lobed at the extremity of the submedian nervure, sometimes erose, sometimes also entire. Abdomen generally shorter than the hind wings; in the male the extremity of the alimentary canal protected beneath by a horny sheath, which extends beyond the centrum, sometimes nearly to the extremity of the parts beyond, thus always carrying the anal opening beyond the centrum; or, to express it differently, the lateral arms originate from the lower surface of the centrum, from the very base, permitting a passage for the alimentary canal between them and the centrum.

Egg. Compact, the height about equal to the diameter, the sides comparatively high above, and furnished with a moderate number of not very elevated longitudinal ribs, extending from about the edge of the base to the flatter portion of summit and crossed by numerous delicate, transverse lines.

Caterpillar at birth. Last abdominal segment furnished with simple tapering hairs, with a slight backward arcuation.

Mature caterpillar. Comparatively stout, the head more or less quadrangular, about as broad above as below; the abdominal segments divided by transverse creases into no more than five sections.

Chrysalis. Comparatively stout, the body largest at the third abdominal segment, the head generally a little narrower than the thorax; always rounded in front in the middle, but never mucronate; tongue case short, not protruding beyond the tip of the wings.

The males of the butterflies of this group may, at least in our fauna, be distinguished from those of the other by the presence of a costal fold on the basal half of the fore wings, often obscure, and which includes a sort of silky down, in general appearance similar to, but more delicate than, that found in the fold of the inner margin on the hind wings of some Papilioninae.

The higher forms comprised in our first section, the Eudamini of Mabille, differ a little from the lower (Antigonini of Mabille) in the mode in which the wings are held in repose, in which respect they generally resemble, as Wallace has remarked (*antea*, p. 1369), the majority of butterflies, all the wings being equally erect. They also differ from them in the greater stoutness of the body and their remarkable swiftness of flight, "which I believe," says Wallace (*Trans. ent. soc. Lond.*, [2], ii: 364), "exceeds that of any other insects. The eye cannot follow them as they dart past, and the air, forcibly divided, gives out a deep sound, louder than that produced by the humming bird itself." These higher genera, too, are almost wholly peculiar to America and entirely absent from Europe, while the lower forms (our second section, the Antigonini of Mabille) are common to both continents, and in the temperate zones are perhaps nearly equally abundant in both. In these lower forms the wings are either perfectly or almost perfectly expanded, or else they begin to show an inequality of position, mostly peculiar to the tribe below.

The prevailing color of the butterflies of this group is dark brown, marked with squarish or angular white or translucent spots; tawny tints are seldom found. The antennae generally have a long club, roundly bent

or with a sinuous lateral curve; in the former case, comprising the higher genera, the club is pretty stout; in the latter it tapers very gradually. There is some variety in the form of the wing, some genera being provided with long tails to the hind pair, while others have the hinder edge of the same wings scalloped or oddly excised.

The eggs of this group are always longitudinally ribbed and transversely lined, in which respect they are widely different from those of the Pamphilidi.

The caterpillars generally feed upon Leguminosae, but also upon a variety of other angiosperms, and live in horizontal nests formed by bending over a portion of a leaf, and fastening it to the rest by distant broad bands of silk, often so long as not to bring the different parts of the leaf in contact; or, later in life, they draw together several leaves in a similar manner.

The chrysalids are smooth and rounded, frequently of a mahogany color, of a compact form, with scarcely any protuberances, and are enclosed in a cocoon often made of the last larval nest more closely bound together, or of a similar one constructed for the purpose, within which the caterpillar weaves Y-shaped shrouds upon which to support the body.

Table of the genera of Hesperidi, based on the egg.

Vertical ribs not much higher on the arching shoulder of the egg than in the middle of the sides; cross lines exceedingly frequent, breaking up the interspaces into cells more than eight (8-11) times as broad as high.

Egg broadly truncate above, over a space about equal in width to half the width of the egg; vertical ribs not over fifteen in number.

With at most twelve vertical ribs. Egg an eighth broader than high.....**Eudamus.**

With more than twelve vertical ribs. Egg a fourth broader than high.....**Achalarus.**

Egg regularly domed above, with no portion truncate; vertical ribs at least fifteen in number.

With sixteen to nineteen vertical ribs. Eggs less than a fifth broader than high.....

Epargyreus.

With about fifteen vertical ribs. Eggs a fourth broader than high.....**Thorybes.**

Vertical ribs generally at least twice as high on the arching shoulder of the egg as in the middle of the sides; cross lines not so frequent as above, the cells being less than eight (4-7) times as broad as high.

Vertical ribs less than twenty in number.

The vertical ridging of the egg quite similar in thickness above and below, except that the ribs are often less numerous above.....**Thanaos.**

The vertical ridging of the egg very dissimilar above and below, some of the thin, compressed ribs of the lower half of the egg being transformed above to coarse, broad, rounded ridges of a unique appearance.....**Phollocera.**

Vertical ribs more than twenty in number.....**Hesperia.**

Table of genera, based on the caterpillar at birth.

Head excessively large; dorsal shield of first thoracic segment conspicuous; first pair of thoracic legs conspicuously more corneous than the others.

First thoracic segment with only the dorsal shield corneous.

Dorsal shield of first thoracic segment not nearly reaching the spiracles on the side....

Eudamus.

Dorsal shield of first thoracic segment reaching and including the spiracles on the side.

Achalarus.

First thoracic segment completely corneous.....**Thorybes.**

Head only moderately large; dorsal shield of first thoracic segment inconspicuous; all the thoracic legs alike in texture.

Head subpyramidal, much narrower above than below.....**Epargyreus**.

Head rounded subquadrate, as broad above as below.

First thoracic segment with dorsal shield scarcely distinguishable from rest of segment.....**Thanaos**.

First thoracic segment with dorsal shield slightly corneous.....**Pholisora**.
Hesperia not examined.

Table of genera, based on the mature caterpillar.

Head at least as high as broad, the highest point of each lateral half of the head inside the middle line of that half; frontal triangle vertically carinate; dorsal shield of first thoracic segment obvious.

Papillae of body inconspicuous, except from coloring.

A distinct indurated spot at the base of the long, infralateral hair of the second thoracic segment; a conspicuous, bright-colored, lateral stripe, the transverse markings in dots only.....**Eudamus**.

No distinct infralateral, indurated spot on second thoracic segment; markings wholly transverse and in broken lines, the longitudinal markings being wholly interrupted.

Epargyreus.

Papillae of body conspicuous, giving it a granulated appearance.

Collar half as broad as the head.....**Achalarus**.

Collar distinctly less than half as broad as the head.....**Thorybes**.

Head distinctly broader than high, the highest point of each lateral half at or outside the middle of that half; frontal carina not distinctly carinate medially; dorsal shield of first thoracic segment inconspicuous or distinct only at posterior edge.

Head distinctly angulated at the upper outer corner, as seen on a front view; hairs of head simple; dorsal shield of first thoracic segment homomorphous; no laterodorsal series of chitinous annuli.....**Thanaos**.

Head regularly rounded at upper outer corner; hairs of head branching; dorsal shield of first thoracic segment heteromorphous, the hinder edge conspicuous; a laterodorsal series of chitinous annuli.

None of the abdominal hairs longer than the shorter sections of the segments; second pair of thoracic legs resembling the third pair more than the first.....**Pholisora**.

Among the abdominal hairs are many, serially arranged but distant from each other, much longer than the sections of the segments; second pair of thoracic legs resembling the first pair rather than the third.....**Hesperia**.

Table of genera, based on the chrysalis.

Abdomen exclusive of cremaster no longer than the rest of the body; length of mesonotum equalling the width between basal wing tubercles; cremaster comparatively stout, subtriangular.

Very stout bodied; head and prothorax noticeably narrower than the thorax; prothoracic spiracle with no posterior, elevated, flaring lip.....**Epargyreus**.

Less stout bodied; head and prothorax scarcely narrower than the thorax; prothoracic spiracle with a posterior, elevated, flaring lip.

Mandibular plate gently and uniformly convex.

Prothoracic spiracle opening forward and outward.....**Eudamus**.

Prothoracic spiracle opening forward only.....**Achalarus**.

Mandibular plate with a distinct, central, hemispherical, hairy tubercle.....**Thorybes**.

Abdomen exclusive of cremaster longer than the rest of the body; mesonotum not so long as the width between the basal wing tubercles; cremaster comparatively slight, elongated.

Posterior lip of prothoracic spiracle scarcely raised, not flaring; body with only very short and fine hairs, wholly inconspicuous.....**Thanaos**.

Posterior lip of prothoracic spiracle much elevated, flaring, fluted; body provided with many long and rather coarse hairs.

At base of the cremaster beneath a large, double, oval swelling enclosed anteriorly by a closely fitting, rather prominent ridge; equal apical portion of cremaster viewed from above scarcely longer than broad.....**Pholisora**.

Base of cremaster, beneath, exceptionally uniform, with no transverse ridge; equal apical portion of cremaster, viewed from above, twice as long as broad.....**Hesperia**.

Table of genera, based on the imago.

Of larger size; hind wings either tailed or distinctly angulate at the tip of the submedian nervure; first forking of median vein of hind wing but little if any nearer the base than the first subcostal division; second median nervule of fore wing opposite the first subcostal fork or a point between it and the second; antennal club hooked, the tip generally bent backward at less than a right angle; terminal palpal joint ovate, at most hardly more than twice as long as broad.

Hind wings with a distinct tail or projecting tooth at the tip of the submedian nervure.

Hind wings with a long tail..... **Eudamus.**

Hind wings with a projecting tooth only..... **Epargyreus.**

Hind wings merely angulate at the tip of the submedian nervure.

Hind wings produced in the submedian area, the submedian nervure being longer than the subcostal beyond the costal divarication..... **Achalarus.**

Hind wings produced in the subcostal area, the subcostal beyond the costal divarication being longer than the submedian nervure..... **Thorybes.**

Of smaller size; hind wings regularly rounded next the tip of the submedian nervure; first forking of median vein of hind wing much nearer the base than the corresponding forking of the subcostal; second median nervule of fore wing opposite the second or third subcostal fork; antennal club sickle-shaped, the tip generally bent backward at more than a right angle; terminal palpal joint linear, four or more times as long as broad.

Antennal club generally terminating in a fine, long drawn point; if not, the antennae half as long as the fore wing; opposite claps of male abdominal appendages asymmetrical...

Thanaos.

Antennal club but slightly tapering on apical half, the tip bluntly pointed, the whole antenna less than half as long as the wing; opposite claps of male abdominal appendages symmetrical.

Almost wholly black, at most with a few white dots on the fore wings, the fringe unicolorous; antennal club six or seven times as long as broad, tapering very regularly and gradually from the middle in either direction; at a distance from the tip equal to half the extreme breadth, much less than half as broad as at greatest.... **Pholisora.**

Much checkered with white on both wings, the fringe with alternating colors; antennal club not more than four or five times longer than broad, tapering much more rapidly next the tip than before; at a distance from the tip equal to half the extreme breadth, fully half, sometimes more than three-quarters, as broad as at greatest.... **Hesperia.**

SECTION I.

Egg with vertical ribs of nearly equal height throughout, the cross lines exceedingly frequent, making very elongated cells. *Caterpillar* at birth with the thoracic dorsal shield usually conspicuous. *Mature caterpillar* with the head at least as high as broad; frontal triangle mesially carinate; dorsal thoracic shield obvious. *Chrysalis*. Mesonotum as long as its greatest width; cremaster stout, subtriangular. *Imago*. Species of larger size; hind wings either tailed or distinctly angulate next anal angle; subcostal and median veins of hind wings forking for the first time at about equal distances from the base; club of antennae hooked; last palpal joint ovate, at most hardly more than twice as long as broad. Wings held erect in repose by day.

GENERA: **Eudamus, Epargyreus, Achalarus, Thorybes.**

* Not including the costo-subcostal divarication. † As in *Thanaos* brizo.

EUDAMUS SWAINSON.

Eudamus Swains., Zool. Ill., II: 48 (1832-1833). Thymele Kirby et al., nec Fabr.

Goniurus Butl., nec Hübn.

Type.—*Papilio proteus* Linn.

Then didst thou pass me in radiance by,
 Child of the sunbeam, bright butterfly!
 Thou that dost bear on thy fairy wings,
 No burden of mortal sufferings!

HEMANS.

Imago (57:5). Head very large, profusely clothed with short, equal hairs, arranged mostly in transverse appressed ridges, the principal one connecting the bases of the antennae; a short, rather thick, equal bunch of bristly arcuate hairs are emitted from the exterior base of the antennae and curve over the eyes, scarcely more than one-sixth of their semi-circumference in length; the whole of the front projecting considerably beyond the front of the eyes, so prominent across the middle as to be elevated into a sort of transverse ridge, the most elevated part of which is in the middle of either lateral half, equalling in prominence the basal joint of the antennae; the upper and lower halves of the front divided by this ridge at scarcely more than right angles to each other; laterally the border of the front is rounded, scarcely surpassing the middle of the front of the antennal base, and so not reaching the edge of the eyes, in front and behind scarcely convex, scarcely more than twice as broad as long. Vertex a little tumid, rounded from in front backward, but not laterally, scarcely reaching the level of the eyes, slightly longer than the front, meeting it by a considerable sulcation, scarcely arcuate, most of it lying between the middle of the antennal bases, but at the extremities curving forward a little; and from the occiput by a brace-shaped, scarcely impressed sulcation. Eyes large, full, slightly more broadly rounded behind than in front, naked. Antennae inserted with their hinder edges at the middle of the summit in slight pits, their interior bases separated from each other by two and one-half times the diameter of one of the basal joints, exclusive of the crook nearly one-fourth longer than the abdomen, the whole composed of fifty-four joints, of which the last twenty-nine form the club, which is nearly one-third of the whole length, and bent just beyond its middle at the thirty-sixth or thirty-seventh joint; the basal two-fifths of the basal half of the club is gradually incrassated, and the apical three-fifths of the same is of a nearly uniform thickness, subcylindrical and equalling in width the length of three of the joints; the club commences to taper just before its bend and tapers very gradually and regularly in a subquadrate form to a rounded tip, which has one-half the diameter of the antennal stalk; the longest joints of the stalk are about three times as long as broad, and the crook is generally recurved pretty sharply, at much less than a right angle. Palpi very short and exceedingly stout, scarcely longer than the eye, heavily clothed with scales, which, excepting on the apical joint, are long and erect and form a dense mass; the basal joint broader than long, bulbous, its apex hollowed for the reception of the middle joint and the anterior portion produced to a considerable extent; the second joint tumid, pretty regularly ovate, twice as long as broad and twice as long as the basal joint, nearly straight, the apical joint minute, tumid, scarcely one-fourth the length of the middle joint, with a short basal stem by which, although seated above the middle of the tip of the basal joint, it is directed downward considerably; it is tumid and slightly longer than broad.

Prothoracic lobes half as long as the eye, strongly appressed, laminate, viewed from the front subfabiform, nearly one-half as long again as high, highest interiorly, sloping off exteriorly above, the lower surface a little convex, the inner margin nearly straight. Patagia large, long, slender, the posterior lobe a little arcuate, half as broad as the extreme base, two and one-half times longer than broad, scarcely tapering until near the tip, which is rather broadly rounded.

Fore wings (41:6) triangular, nearly twice as long as broad, the costal margin, excepting at the extreme base, straight in the basal half, beyond which it begins to curve and is feebly arcuate in the apical half; upper half of the outer margin moderately convex, almost bent at the independent nervule, the lower half straight with a slight prominence at the submedian nervure; the apex of the wing is strongly bent at less than a right angle, the extreme apex rounded off; the anal angle, on account of the fulness of the wing at this point, is bent at about a right angle, the inner margin straight, or with the least possible broad median excision. Costal margin strongly thickened in the basal half of the wing; costal nervure terminating almost as far beyond the tip of the cell as the width of the latter; first superior subcostal nervure originating opposite the second median nervure at about three-fifths the distance from the base to the apex of the cell; the fourth superior subcostal nervure arising just before the apex of the cell, and enclosing between its tip and that of the subcostal nervure the apex of the wing; the second and third at equal distances between the first and fourth; first inferior subcostal nervure bent at a strong angle at its base to form a part of the closure of the cell, as far from its base as that is from the origin of the fourth superior nervure; beyond this it runs directly to the margin, excepting for a considerable basal arcuation, by which it approaches the subcostal nervure proper, which in its turn here slightly diverges toward it; first median nervure arising near the middle of the basal half of the cell, the second at a long distance beyond, the main vein connected with the basal angle of the first inferior subcostal nervure by an extremely feeble oblique vein, which parts from it nearly opposite the origin of the third superior subcostal nervure, and from the middle of it arises the independent vein; from the median nervure shortly before the union with the feeble cross vein, a recurved shoot runs almost to the centre of the cell; internal nervure short, distant from the submedian, turning abruptly upward and running into it below the origin of the first median nervure; cell about eight times as long as broad, and more than two-thirds the length of the wing.

Hind wings, exclusive of the tail, much longer than broad, the costal margin very strongly and regularly rounded at the base, the outer angle strongly rounded, not much produced, the outer margin very slightly convex, feebly crenulate, and as far as the tail, which is a long and broad expansion of the membrane, equal on either side of the submedian nervure; this expansion is equal and lengthens the wing by from one-half to the whole of its discal length, and is straight or slightly curved outward; the inner margin is straight but for the decided and well rounded lobe, whose highest point is just within the extremity of the internal nervure. Costal nervure strongly bent at the base in almost perfect correspondence with the margin of the wing; the precostal very insignificant, hardly to be noticed but for the enlargement of the main vein at its base, which is close to the base of the wing; subcostal nervure running nearly parallel to the extreme base of the costal, as far as the enlargement mentioned, which bends downward to meet it and so encloses between the two a slight, long-oval lacuna; from this point the subcostal bends at nearly a right angle and runs in a straight course, forking at about one-third the distance to the margin; median forking scarcely sooner than the subcostal, united barely beyond its last divarication with the subcostal by a cross vein, which is obsolete, excepting at its extremities, but runs parallel to the margin of the wing.

The scales enclosed in the costal fold of the male include an elongated chain-bristle with apical flagellum, a lanceolate but apically enlarged androconium and a peg-like form of minute size.

Legs 2, 3, 1.* Under surface of fore femora equally and closely tufted with very short hairs; middle and hind femora tufted loosely with very long hairs on the basal half, the middle pair with shorter ones on the apical half; hind tibiae equally tufted with long hairs above; femora 2, 1, 3; tibiae 2, 3, 1; tarsi 3, 2, 1; fore and hind

* In this way, in the present family, I propose to indicate the relative length of different members, the longest being placed first; where a line crosses more than one they are equal.

femora of equal length, middle femora half as long again. Fore tibiae two-thirds the length of fore femora and a little more than half as long as the middle and hind tibiae; these are equal, the middle pair nearly as long as its femora, the hind tibiae one-third longer than the hind femora. Leaf-like appendage of fore tibiae long and very slender, originating scarcely beyond the middle of the joint, surpassing its extremity a little, more than four times as long as broad, a very little arcuate, especially in its apical half, bluntly pointed at the tip. Middle tibiae with a pair of stout, apical spurs, hind tibiae with a similar apical pair and a second just beyond the middle of the joint; tarsi 1, 2, 3, 4, 5; fore tarsi rather more than two-thirds as long as the middle, rather less than two-thirds as long as the hind tarsi; hind tarsi one-fourth longer than middle tarsi; all the tarsi with a triple row of slender spines beneath, the apical ones of the outer rows of each joint a little longer than the others; basal joint as long as the second, third and fourth together on the hind legs, as long as all the rest together on the other legs; second joint about two-fifths as long as the first. Claws small, the apical half bent considerably, the basal half tapering, acutely pointed. Pad large, bullate, apically transverse and appressed, from the middle of the sides of which project minute, conical, pointed paronychiae resembling the apical third of the claws.

Male abdominal appendages having the centrum of the upper organ a little compressed but tumid, well arched and prominent posteriorly. Hooks as long as the centrum, independent, parallel, nearly horizontal and straight, slender, compressed and not pointed; lateral arms forming a simple sheath extending nearly to the tip of the hooks. Clasp large, nearly equal, twice as long as broad, but little convex, posterior edge angulated near the middle; upper posterior angle slightly prominent and denticulate.

Egg. Broader than high, broadest near the base, the sides nearly equal, above strongly arched and at summit truncate, with a distinct shoulder at the base of the dome, furnished with a rather scanty number of vertical ribs, hardly so high as broad, broadest on the domed portion, fading below on the sides to nothing at the base, all of them extending to the micropylar basin which is of unusual size, saucer-shaped; the ribs have a denticulate or granulate appearance where highest from the alternation of course due to the impinging of the cross lines which run at very brief intervals in a straight course traversing the interspaces, at least in the upper half of the egg; the interspaces are scarcely waved but almost perfectly flat. Described from specimens in glycerine.

Caterpillar at birth. Head large, well rounded, scarcely bilobed, broadest below, narrowest above, of about equal height and breadth; the front well rounded on a side view; triangle half as high as the head, somewhat higher than broad; furnished with a few definitely arranged, short, curving and tapering bristles; mouth parts enclosed in a transverse, broad oval, hardly more than a third as broad as the head; ocelli five in number, equal; four equidistant in a regular, arcuate row, its convexity forward; the fifth posterior, on a level with the third from the top and forming with it and the uppermost a nearly equilateral triangle. First segment of the body with a broad, equal, dorsal shield, conspicuous, not nearly reaching the spiracles on either side; the body equal, furnished with many straight, rather stout bristles about half as long as the segments, scarcely expanding apically but cup-shaped with a sharp rim; they are apparently disposed in longitudinal rows very much as in *Epargyreus*, the mode in which my specimens are mounted not permitting a more exact statement. First pair of legs horny, the other more fleshy; both with similar, strongly hooked, mesially bent, compressed, minute claws; prolegs short, stout, stumpy, the hooklets somewhat similar to the claws of the other legs but not more than a quarter as large, without a heel; they are arranged in an oval to the number of about twenty on the ventral prolegs. Described from specimens mounted in glycerine.

Mature caterpillar. Head subglobular, the sides strongly arcuate, almost bent in the middle where it is broadest; the summit nearly flat and half as wide only as the middle of the head; very broadly arcuate beneath, the inner frontal triangle nearly twice as high as broad, reaching just above the centre of the head; the head of equal height and breadth, fully twice as high as deep, deepest in the middle, scarcely less

deep below, the front receding above to a well rounded summit, having a precipitous posterior slope, the hinder edge of the head being truncate; the surface is more or less rugulose, and covered with a very fine, very short and exceedingly sparse pile; ocelli six in number, four arranged in a strongly arcuate series with convexity forward, subequidistant, the fifth posterior to the third from the top and as distant from it as the uppermost; the sixth, next the outer posterior base of the antennae, as distant from the fifth as the fifth from the first; these three with the fourth at the angles of a very elongated lozenge.

Dorsal shield of the first thoracic segment conspicuous, occupying fully the posterior half of the segment, longitudinally arched. Rest of the body very long ovate, largest at the third and fourth abdominal segments, tapering about equally toward either extremity, the last segment broadly rounded and apically subtruncate; abdominal segments divided into a broad anterior section occupying fully one-third of the whole and the remainder into four subequal sections of which the first is directly over the spiracles; the surface covered with exceedingly numerous, regularly distributed, raised points each bearing a short tapering bristle; besides which there are numerous irregularly distributed conical papillae higher than broad, occupying a space equal to half a dozen of the others, each bearing a short, hyaline, tapering, apically open but not expanded hair; there is also a low, infrastigmatal series of very minute, perfectly circular, crateriform annuli, not a twentieth as large as the spiracles, and scarcely in advance of them, on all the abdominal segments, on the first abdominal segment placed directly beneath the spiracle and distant from it by its own length; in a similar position, halfway between the spiracles and the legs, a pair of these annuli are found upon the first thoracic segment. Legs with the basal fleshy joints very stout, the chitinous portion appressed, slender, tapering; the hook strongly bent and finely pointed; prolegs stout, blunt, with an apical, complete circlet of strongly arcuate hooks, arranged in triple rows, the hooks shaped very much as the claws of the legs but bent less strongly, and beyond rather than before the middle, regularly tapering, strongly compressed.

Chrysalis. Head and prothorax separated by a distinct and rather deep sulcation from the mesothorax, forming a nearly rectangular mass with rounded corners, twice as broad as long and as broad anteriorly as posteriorly; front gently and slightly protuberant on the middle third and on all the protuberant portions very sparsely and finely pilose; mesothorax tumid, a little longer than broad, rather angulate at the basal wing prominences, which show a distinct but slight double superior and inferior elevation; beyond this the body narrows very slightly to the abdomen, then gradually increases again to a width, at the third abdominal segment, slightly greater than that at the basal wing prominences, beyond which it tapers with some rapidity over three or four segments, then much more rapidly to a conical tip; viewed from the side the dorsum of the mesothorax is gently arched, with a more rapid descent behind than in front, beyond which the dorsal line is straight over the fixed abdominal joints and then slopes gradually to the cremaster; the front is roundly angulate beneath, the ventral slope as far as the extremity of the wing very gentle, scarcely more arcuate posteriorly than in front, the wings being in the very slightest degree protuberant. Prothoracic spiracles exceedingly large, auriculate, semilunar, with protuberant flaring posterior lip, their outer extremity surpassing the width of the prothorax; guarded posteriorly by a broad semi-annulus of dense, excessively short bristles and protected in front by a sparser collection of similar bristles upon the prothorax. The position of the mandibles marked by a scarcely perceptible callosity bearing a few bristles. Posterior legs reaching as far as the antennae, excepting for the width of the tip of the latter; these extending as far as the middle of second abdominal segment, in front of which the thorax slopes rapidly to the slightly narrower prothorax. Moveable segments of the abdomen with a premedian, distinct, blunt carina, encircling the whole body, its posterior face more rapidly abrupt than the anterior. Prenal button supporting the inferior base of the cremaster consisting of a horseshoe-shaped, but somewhat angulate ridge most prominent at the angles, from which, but disconnected with them, diverge dull lateroventral

ridges crossing the ninth abdominal segment; within the embrace of the horseshoe-shaped ridge is found a roundish sunken floor with a longitudinal fissure. Cremaster as long as the seventh to ninth abdominal segments, as viewed from above broad at the base, immediately contracted and beyond tapering to a truncate tip with rounded angles; the base with a deep and large triangular sulcation; beneath, it is very broadly and somewhat uniformly sulcate throughout; viewed laterally it is arcuate over the narrowing portion, and tapers slightly to a bluntly rounded tip, which is transverse and contains all the hooks; these are long, slender, not enlarging before the extremity of the tip, where they are strongly arcuate, almost coiled, expanded, dorsally rounded, the extreme tip bluntly pointed, bearing a reversed, slightly compressed cup.

This is one of the most characteristic genera of American Hesperidae and finds its metropolis in the tropical parts of the continent; it is composed of numerous widely distributed species and reaches to about the 33d degree of North Lat., and probably to the same degree on the southern continent; one species, following northward the warm Atlantic shores, has been found in a few instances as far north as New York city, and in a single locality in Connecticut.

The butterflies of this genus may at once be distinguished by the long heavy tails to their hind wings, supported by a prolongation of the submedian nervure. The upper surface of the wings is dark brown, the front pair adorned with a transverse median series of irregular squarish, vitreous spots of medium size and a strongly arcuate series of similar smaller spots descending from the costal border near the apex and striking the middle of the transverse series. Beneath, the wings are paler and grayish, the hind pair traversed transversely and more or less distinctly by two blackish stripes of moderate width, the inner fuscate next the costal margin.

The history of the different species is but little known; the one with which we have to deal is double brooded, the imago flying in August and at the end of September, the latter probably hibernating; the chrysalis of the first brood continues over six weeks.

"We are informed by Mr. Swainson," says Westwood (Gen. diurn. Lep., ii: 540). "that the flight of the butterflies of this genus is exceedingly rapid in the morning and evening, and that they rest with all the four wings horizontally extended." Wallace says they prefer open ground in the hot sunshine.

The caterpillars taper considerably toward either end, the neck being quite small, the head very large and considerably bilobed above; the body is green, striped longitudinally with yellow and dark green and specked with dusky spots.

The chrysalids are well rounded, the thorax more than usually arched, the wing sheaths pretty full and the abdomen tapering only on the apical half.

EXCURSUS LIII.—EFFECT OF COLD ON DEVELOPMENT.

If the butterfly courted the bee,
 And the owl, the porcupine;
 If churches were built in the sea,
 And three times one was nine;
 If the pony rode his master,
 If the buttercups ate the cows,
 If the cat had the dire disaster
 To be worried, sir, by the mouse;
 If mamma, sir, sold the baby
 To a gipsy for half-a-crown;
 If a gentleman, sir, was a lady,
 The world would be Upside-Down.
 If any, or all of these wonders
 Should ever come about,
 I should not consider them blunders,
 For I should be Inside-Out.

Topsy Turvy World

ONE has but to compare the variety of butterflies found in the tropics with that found in the temperate zones to measure the effect of winter upon butterfly life in general; for though the dry season of the tropics in part offsets the winter of the cooler regions, there is then no such pervasive suspension of vitalities. So far as butterflies are concerned, the number is comparatively few of those whose sustenance is drawn from plants which are dormant in the dry season and wither to the ground; and heat and dryness are in themselves no bar to the growth or enjoyment of the former. The same cannot be said of the cold; not only does it practically destroy the means of sustenance, but it itself condemns to inactivity; and without activity is no growth.

The lives of butterflies in temperate climes is therefore far different, and, relatively speaking, probably far more varied than in the tropics. The cold winter when all activities cease is met by some at one stage, by others at another, by not a few in more than one stage. Rarely does any special provision seem to be made to meet it; it is as if winter had come upon a given species when members of all stages were astir (as often happens now in semi-temperate regions) and only such stage or stages as are best fitted withstand the shock, until a particular hibernating stage becomes fixed in its history.

The most noticeable and general effect of cold upon the development of butterflies is seen in the number of annual generations or cycles in different latitudes, whether a single species is considered or the whole body of butterflies. Thus Brunbauer states, as the result of his comparisons of the life histories of the components of the European butterfly fauna, that north of the Alps one or two generations are the rule, south of the Alps three or more, never, he thinks, exceeding five; while if we except the few species of this country which everywhere show only a single generation—mostly confined to boreal and alpine types—the pages of the present work show hardly an exception to the rule that butterflies which in New England have

only two generations, are plural brooded in the southern states; and so far as our still very insufficient information goes, it tends to support the statement that in general a brood is added in each great faunal belt, the change occurring not far from the delimiting lines between the faunas. This is perhaps most marked in the Pamphilidi, which in the Canadian fauna are almost invariably monogoneutic, and seem in the Carolinian to be as commonly trigoneutic.

Now the effect of temperature is seen not only in the histories of our butterflies, but in many cases in their very structure; the first brood of a given butterfly for any year differing from the subsequent brood or broods, sometimes to a marked degree; so much so, that in not a few cases they have been first described as distinct species. These differences are in the main confined to the color and patterns of the wings, but are sometimes seen in the size and form of the wings themselves, in the abdominal appendages of the males and in one instance at least in the clothing of the head. Where there are several broods in the year, no differences whatever have been detected between the members of the broods subsequent to the first; it is only the first which differs from all the others alike, showing pretty clearly that it is cold acting upon the creature in the preparatory stages of its life, and not heat, which is the prime agent in this class of distinctions; in support of this we also find in a few cases differences between the earlier and later appearing members of the first brood, the later members showing an approach toward the summer forms.

This would seem to be a strong objection to the theory advanced by Weismann that the winter-form so called, that is, the first brood of seasonally dimorphic butterflies, is the primeval form of the species. Considering the vast preponderance of butterfly variety in the south and the almost universally intimate alliance of the northern butterfly fauna to the southern, there can be no doubt that the butterfly is *par excellence* a creature of the tropics and the northern fauna in no proper sense endemic, but a colonial offshoot from the southern. It would seem to follow that the seasonal dimorphism of the north (imitated, so to speak, in the south in the dry and wet season butterflies, as de Nicéville has shown) is a phenomenon superinduced in the colonist by the new conditions in which it finds itself; and the summer type should therefore be looked on as the normal and primeval.

It is a significant fact that in most, perhaps all, butterflies which show marked seasonal dimorphism, the hiemal condition is that of the chrysalis; for it points directly to the conclusion, borne out by experiments in the laboratory, that the divergence of the spring from the summer type is the effect of cold upon the insect in the chrysalis state. These experiments have not been so extended nor so complete as not to leave the matter still open to investigation before a final conclusion may be warranted; but

they have been made in a variety of instances, the chrysalis which would normally produce the summer type having been made in many instances (though neither uniformly nor always to a like degree) to yield the spring type. The most extensive, complete and varied of these experiments have been made in this country by Mr. W. H. Edwards, particularly (with success) upon three species, *Polygonia interrogationis*, *Phyciodes tharos* and *Iphiclides ajax*. These researches show that experiment cannot compete with nature in the completeness and invariability of its results, but can only effect changes in the same direction and with some uncertainty. Thus in the first and last of the species mentioned above, there is a difference between the two broods, not only in the coloring but in the shape of the wings. The artificial application of cold to the chrysalis has so far proved unable to cause the anticipated change in the shape, but only in the coloring of the wings; the resultant is the summer type in shape, the spring type in the more conspicuous though less deep seated characteristic of coloring. The effect in *Polygonia interrogationis* has been to melanize, in *Iphiclides ajax* to albinize the general effect of the coloring; in *Phyciodes tharos*, where suffusion is not unknown in nature, the effect, when the change of coloration is not complete, has been to imitate to a greater or less degree such suffusion, and this has been most frequently the result when the exposure to severe cold has begun before the chrysalis has hardened. This would lead to the presumption that such instances in nature occur when the change to pupa takes place (as it ordinarily does not) at the close of the day, followed by a colder night than usual.

The actual temperature of the chrysalis indeed depends very much upon the temperature of the circumambient air or of the object on which it may rest, never varying from it many degrees when it is quiet (as chrysalids usually are) nor indeed when it is active. Once when the air was $64^{\circ}.5$ F. I placed a delicate thermometer against the body of the chrysalis of *Vanessa cardui* and found the chrysalis one degree warmer than the air. I annoyed it, causing it to keep up a vibratory motion implying much muscular activity for about a minute, and then the thermometer placed against it rose another degree, to $66^{\circ}.5$. On another occasion at 10 A. M., the thermometer at 71° , I placed it against the hanging chrysalis of the same butterfly and it rose to 73° ; then I placed it against the chrysalis of *Thorybes pylades*, which had been lying upon a cool piece of marble throughout the night, and it fell to $70^{\circ}.5$.

There is a further difference between the generations, extending in a limited way to the different summer broods, in the period required for the complete transformations, affecting all the preparatory stages. Cold induces inactivity and all stages are retarded during cold or even cool weather. There is much individuality in this respect and the differences that appear in successive seasons are often marked, as every field entomolo-

gist knows. The winter sleep especially is very varied from year to year, differs more in some species than in others and differs also in the various stages; in general it may be said that it is shortest in the imago, longest in the chrysalis, and about equal in the egg and the caterpillar, though there are of course many exceptions to any such general statement.

Finally there is often seen a difference, plainly attributable to temperature, between butterflies of the same species or between species of the same genus, according as they are found in more northern or more southern latitudes, showing itself principally in size, greater in the south, and in general tone of color, the markings being generally less vivid and more melanic in the north; doubtless much more is to be learned in this direction by careful investigation.

It might perhaps be thought by some that the nature of the food plant had not been sufficiently taken account of in the experiments cited; that experiments should be made to see whether in such seasonally dimorphic forms the subsist perforce in their different broods upon different food plants, *Cyaniris pseudargiolus* for example, the dimorphism be not rather polyphagous than seasonal; or more properly whether the actual seasonal dimorphism be not a simple result of different nourishment. But a moment's consideration will show that the most marked cases or most of them occur where no diversity of food plants exists, and that there is no known dimorphism even between the later broods of *Cyaniris pseudargiolus* where such diversity is found. Such phenomena, therefore, unquestionably have their origin in the effect of cold upon the development of butterflies.

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EUDAMUS PROTEUS.—The long-tailed hesperid.

[Swallow-tailed skipper butterfly (Abbot); the roller-worm (Comstock); long-tailed skipper (Maynard).]

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Figured by Abbot, Draw. ins. Ga., Oemler coll., Bost. soc. nat. hist., 24; —Glov., Ill. N. A. Lep., pl. 1, fig. 14 (3 figs.); pl. 29, fig. 1, ined.

. . . Unendlich wunderbar Wesen!

. . . Du bist so herrlich . . .

In einer kriechenden Raupe, wie in dem flammenden Cherub.

KLEIST.

What think'st thou of the gentle Proteus?

SHAKESPEARE.—*Two Gentlemen of Verona*.

Imago. (15: 1) Head covered above with rather dark grass or metallic green hairs, mingled behind with yellowish green, in front with brownish ones; tuft on either side of the antennae composed of dark brown hairs; beneath sordid white, with a yellowish tinge, passing upward in a slender line to the middle of the hinder border of the eye; palpi similarly colored on the basal joint; middle joint the same, but profusely and beneath pretty uniformly flecked with brown scales, which on the outside and above become elongated, more frequent and are mingled with black bristles externally, with greenish elongated scales above; apical joint brown, beneath almost wholly dull white; antennae pretty uniform, very dark brown, the club and crook clay yellow beneath, the latter elsewhere naked and dull castaneous.

Thorax covered above with long green hairs, having a slight olivaceous hue in front, and a slight plumbeous one behind; beneath with mingled pale brownish purple scales and yellow and brownish hairs. Legs very dark brown, often with a dark olivaceous or purplish tinge, flecked infrequently with yellow scales, but along the posterior half of the tibiae and tarsi and at the extreme tips of the tibiae and basal joints clay or brownish yellow; under surface of femora pale or nacreous; leaf-like appendage of fore tibiae luteo-castaneous; spurs brown above, clay yellow beneath, reddish at tip; spines reddish brown; claws the same but darker; pad brownish fuscous.

Wings above very dark chocolate brown; fore wings covered pretty profusely on the lower half, and especially toward the base, with olivaceous green hairs, directed downward and outward; the veins are often darker than the ground color; crossing the middle of the wing in a scarcely arcuate line, its convexity inward, from the middle of the basal four-fifths of the costal margin to the outer margin, in the middle of the lower half of the medio-submedian interspace, is a series of four irregular, unequal, subfenestrate white spots, the lowermost of which is slightly outside of the straight line, which may touch the centre or the interior limits of the others; the upper, above the subcostal nervure, is subquadrate and double, longitudinally divided; the second, which crosses the cell, is about as broad as long above, but narrows below, and is constricted in the middle; the third in the lower median interspace is largest, subquadrate, but approaching the shape of that in the cell; while the lowest, in the upper half of the medio-submedian interspace, is usually the smallest and attenuated below; these spots are sometimes so closely connected as almost to form a band; another spot, similar to that in the lower median interspace, but usually slightly smaller, is found in the middle of the basal two-thirds or four-fifths of the upper median interspace; toward the apex of the wing, depending from the middle of the

outer two-fifths of the costal margin, is a strongly arcuate series of five unequal, similar, but small spots, its convexity outward, terminating at the middle of the outer two-thirds of the upper median nervule; the upper three only are regularly present; the upper two are subequal, longitudinally quadrate, and in a line at right angles to the costal margin; the third is square and just below the exterior limits of the others; the lower two are transverse, hour-glass shaped, the upper usually so much constricted as to become double, and the more frequently absent. Fringe dusky, darker than the ground color, at the nervure tips paler and tinged with dull yellowish brown elsewhere, and particularly on the apical half. *Hind wings*, with the disc and inner margin, but not the tail, very profusely supplied with long hairs, varying in different individuals from an olivaceous green to a pale bluish green, or a bright metallic blue green, or a dull leaden green; other parts of the wing, and especially the tail, inclined to blackish. Fringe very dark blackish brown, interrupted with pale, generally dingy yellowish in broad lunules between the nervules, above the lower median nervule.

Beneath: *fore wings* of the same color as above, but with a slight olivaceous tinge, and a little paler in the space enclosed between the median and subapical spots, all of which are exactly repeated from the upper surface; flecked very distantly and inconspicuously with yellowish scales; outer border broadly margined, to the depth of about an interspace, with a paler band of dark lilac-brown, generally palest interiorly and broken by dusky nervures; outer margin narrowly edged with black; fringe of the color of the outer border, but palest interiorly, and interrupted rather broadly and abruptly by blackish at the nervure tips. *Hind wings* pale grayish brown, with a slight olivaceous tinge, and occasionally faintly tinted with lilac; crossed by broad, nearly equal and parallel dark brown, almost blackish belts, and excepting on these, flecked distantly but not inconspicuously with yellow scales; the dark bands consist of three: the innermost runs from the middle of the basal two-thirds of the submedian nervure to the lower subcostal nervule, its interior edge striking the subcostal nervure at its divarication; externally it is narrowly edged with pale in the cell; and just below this is often strangled or even parted; above the subcostal it is parted and forked, consisting of two narrower transverse bars crossing the costo-subcostal interspace, the exterior usually narrower than the other, generally also oblique, or with its costal extremity extending toward the outer margin, and with its interior edge on a line with the exterior edge of the band below it; the interior transverse, its exterior margin striking the divarication of the subcostal; the middle band lies midway between the interior one and the outer margin, extends from the submedian nervure to the upper subcostal nervule, and indistinctly to the costal margin, nearly equal throughout, very slightly arcuate or bent, its convexity inward, the interior border pretty sharply, the exterior rather vaguely defined; the outermost band follows the outer border from the submedian to the upper branch of the median nervure, narrowing as it goes, with a vaguely defined interior margin and leaving but a narrow belt of grayish between it and the middle band; above its extremity, the outer border is often paler than any other part of the wing; the inner border, below the submedian nervure, and including the whole of the tail and its fringe, is blackish brown like the belts, excepting on the basal half of the wing, where it is of a tint similar to the ground color of the wing, and is flecked with yellowish scales; outer margin very slenderly edged with blackish; fringe above the tail whitish or yellowish white, interrupted at the nervure tips with blackish.

Abdomen above of the color of the upper surface of the fore wings, concealed at base by the thoracic hairs; sides like the upper surface, beneath grayish, the extremity of the apical hairs grayish yellow. Appendages of the male (35: 37) with the upper organ having the hooks very slightly arched, slightly tapering on the basal half, rounded at the extremity and slightly uncinate beneath at the tip. Claps a very little more than twice as long as broad, the upper edge a little rounded, hinder edge cut at a little less than a right angle, and slightly produced, the upper hinder angle with two or three minute denticulations, directed upward and a little forward, the upper the largest.

Measurements in millimetres. Length of tongue, 14.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	22.5	24.	26.5	21.	24.	26.5
antennae.....	12.6	13.25	13.5	10.5	12.75	13.5
hind tibiae and tarsi..	10.6	11.25	11.5	9.	10.75	12.
fore tibiae and tarsi..	6.	6.5	7.	5.	6.25	6.5

The length of submedian nerve of hind wing varies from 26-32 mm. (♂), 25.2-33 mm. (♀).

Described from 10♂, 12♀.

Accessory sexual peculiarities. The costal fold of the fore wing of the male is mostly filled with what are apparently silken hairs, but in reality chain-bristles composed of from six to nine, usually eight, subequal links, each about .02 mm. long, and the last flagellate at tip (47: 1a); besides there are in scanty numbers two sorts of androconia, showing only a granular structure; one is a slender lanceolate, apically sagittate scale, about .16 mm. long (47: 1b) and so not much, if any, shorter than one of the chain-bristles; the other a nearly equal obovate scale (47: 1c) not twice as long as one of the links of the chain-bristle. These are the better concealed for the broad striate coverscales (47: 1d) which ordinarily close the opening.

Egg (66: 6). Apparently considerably broader than high. Vertical ribs eleven or twelve in number, at an average greatest distance apart of .22 mm., approaching each other much more closely at their termination at the edge of the micropylar basin, which is nearly .4 mm. in diameter; cross lines apparently at equal distances apart, whether the ribs are closely approximate or distant; in the upper part of the egg (where only they are distinct) about .025 mm. apart; surface of the egg showing the finest possible punctuations with a half-inch lens. Color light yellow (Wittfeld). Width of egg, .9 mm.; height, .8 mm. Described from specimens mounted in glycerine.

Caterpillar. First stage. Head black, sometimes blackish brown, the sutures and posterior edge of the collar black; bristles pellucid; mouth parts castaneous; the spinneret luteous. Dorsal shield of the first thoracic segment of the color of the head, as are also the legs of the same segment. Rest of the body uniform pale yellow, the bristles pellucid; prolegs concolorous, the second and third thoracic legs scarcely darker; spiracles marked by a fuscous ring. Length, 2 mm.; breadth, .32 mm.; breadth of head, .6 mm. Described from specimens in glycerine.

Second stage. Head black, with a brownish tinge and yellowish black pile; the summit of the hemispheres with some minute raised conical points; dorsal thoracic shield of the color of the head. The body uniform yellowish green, with pale, dusky hairs on scarcely infuscated minute papillae. Legs and prolegs as before. Length, 4 mm.; breadth, about .5 mm.; breadth of head, 1 mm. Described from specimens mounted in glycerine.

Third stage. Head black, with a faint, small, reddish spot next the lower outer corner of the frontal triangle; summit of each hemisphere with a distinct cluster of dentiform tubercles. First thoracic segment with dorsal shield scarcely so dark as the head, with a reddish tinge, broken narrowly at the dorsal line. Body uniform yellowish green, the fuscous hairs giving it a slightly begrimed appearance. Legs and prolegs as before. Length, 10 mm.; breadth, 1.3 mm.; breadth of head, 1.7 mm. Described from specimens in glycerine.

Fourth stage. Head (80: 11) piceous, obscured by fine granulations, which are interrupted by finely impressed, vertical striae, converging toward the mouth parts; triangle with a distinct but slight median carina in continuation of the vertical suture above; a bright orange, quadrate, angular spot occupying the space between the ocelli and the frontal triangle, angularly produced next the upper limit of the ocelli; summit of either hemisphere posteriorly with an open cluster of a few denticulate tubercles curving forward; mouth parts blackish; the basal joint of the antennae and the extreme base of the third joint pallid. First thoracic segment with a smooth, piceous, dorsal shield, finely broken at the dorsal line and with a triangular fragment

broken from the extremity below, just above the spiracle; ventral portion of the segment, including the sides as far as the dorsal shield, reddish. Rest of body yellowish green, with a broad, lateral, lemon-yellow stripe, becoming orange posteriorly, and the dorsal field included thereby coarsely marked with lemon-yellow pustules; the same, but to a much less marked extent, upon the sides of the body, as far as the infrastigmatal line; on the second thoracic segment, corresponding to the inferior triangular fragment of the dorsal shield of the first segment, but higher than it, and situated in the middle of the segment, a stout, low, fuscous wart; spiracles luteo-fuscous; first pair of legs piceous, the other blackish fuscous; prolegs orange, with blackish fuscous claws. Length, 21 mm.; breadth of body, 3 mm.; breadth of head, 3 mm. Described from blown specimens.

Last stage (76: 34). Head (80: 12) luteo-castaneous with the orange spot as in the previous stage, but rounded and with the whole centre of the front of the head blackish fuscous, deepest in color beneath and becoming more ferruginous above; a similar spot posteriorly, having its deepest tint in the ocellar field and becoming fusco-ferruginous toward the collar, which is itself of this tint; ocelli vitreous; the denticulations of the summit of the head seen in the previous stages are much subdued; the whole surface is finely granulated, the granules clustering on the summit and posteriorly into small low tubercles and on the front forming a part of a subdued verruculation which toward the lower portion of the head changes to a marked combing or striation converging toward the mouth parts.

First thoracic segment with a piceous dorsal shield on its posterior half having a fuliginous anterior edge, the anterior half dirty yellow; otherwise as in the previous stage, excepting that there are numerous, minute, whitish tubercles between the spiracles and the legs. Rest of the body yellowish green with a distinct, broad, lemon sometimes orange yellow or reddish, lateral stripe, a fine, blackish fuscous, interrupted, dorsal line, an obscure, dull yellow, infrastigmatal stripe and the dorsal parts of the body, especially above the lateral stripe, marked with short, pale lemon yellow, longitudinal combed streaks and irregular, arcuate, sinuous dots or slender, amoeboid patches of blackish fuscous, more conspicuous on the broader anterior section of the segments, and on the shorter section more frequently reduced to mere dots; everywhere irregularly disposed, and when analyzed seen to be made up of a fuliginous ground finely and uniformly dotted with black raised points; on the eighth and following abdominal segments the lateral band becomes broader, of a deeper orange or reddish color, and margins the edge of the terminal segment. Legs and prolegs as before. Length, 45 mm.; greatest breadth of body, 8 mm.; breadth of head, 4.5 mm.; of collar, 2.75 mm. Described from blown specimens.

Dr. Juan Gundlach sends me the following description from living specimens in Cuba: Head of liver color, on each side of the ocelli a red spot; mandibles black. Collar black, the first ring below and on the sides of minium color. The general color of the body is glaucous with little green spots and with black points on the superior part of the stigmata which are dark orange red. The dorsal line is black, on the superior sides of the body is an orange longitudinal band, becoming red behind, where the two are joined over the anal plate. The horny legs are dark brown externally, the fleshy legs are orange colored.

Chrysalis (85: 23). Dark brown, according to Wittfeld; when dried, fusco-luteous beneath, above mahogany colored, more or less tinged with luteo-olivaceous, shining throughout; hairs of the head as well as the scant hairs of the rest of the body luteous; the bristles of the prothoracic spiracles luteo-fuliginous; the posterior lip of the spiracle itself piceous; mesothorax faintly striate in irregular, transverse, wavy, somewhat tortuous, distant lines. Abdominal segments sparsely, irregularly, and rather finely punctate, the punctae fuscous. Cremaster dark fusco-castaneous. Length, 22.5 mm.; width of head, 5.25 mm.; of mesothorax, 6.5 mm.; of abdomen, 7.5 mm.; length of cremaster, 2.25 mm.

Geographical distribution (27: 4). This is a tropical species, being found in the greatest abundance throughout every part of the northern tropics as well as in South America south of the equator, probably throughout the entire extent of the tropics there, possibly even further, but this I have no means of verifying from specimens. It enters our country at its extreme southern limits. I do not find any report of its occurrence far inland; neither Gosse nor Grote mention it from central Alabama, but it is found from southern Texas where it is moderately common (Anron) and along the Texan boundary (Captain Pope) to Florida, where it extends from the Keys (Maynard, Palmer) to Apalachicola (Chapman) and Jacksonville (Palmer.) All the Mexican localities from which I have seen it or noted it were mostly outside the limits of our map and I have no proof of its occurrence on the west coast within our own territory, though its distribution in the east would seem to render it probable that it would be found there; for along the Atlantic sea-board it extends a considerable way to the north, being found in Wilmington Island (Oemler) and the interior of Georgia (Abbot) and in tolerable abundance in South Carolina (Seudder). It has occurred but once in Maryland, to Mr. Uhler's knowledge, and recently a number of specimens have been taken in Central Park, New York by Mr. Elliot.

A few specimens have also been taken about New Haven, Conn. (Smith), the only locality where it has been observed in New England.

Oviposition. According to Comstock, "the eggs are laid in small clusters of from four to six each." Wittfeld writes that they are "deposited on upper and under side of many Leguminosae, mostly on the under side and mostly in clusters of from two to twenty." They are not, however, "with no discernible markings," as Comstock states, but vertically though rather feebly ribbed.

Food plants. This caterpillar feeds upon Leguminosae of different tribes; such as *Wistaria frutescens* D. C. and *Desmodium viridiflorum* Beck (Chapman), *Phaseolus perennis* Walt., "kidney bean" (Abbot, Chapman), *Clitoria mariana* Linn., the butterfly pea or "wild pea vine" of Abbot (Abbot and Smith), and in Cuba on *C. ternata* and other species of the genus (Gundlach). According to Comstock, however, it does not confine itself to leguminous plants but feeds also on Cruciferae, doing in Florida much damage to the crops, particularly beans, turnips and cabbage!

Habits of the larva. Like all the caterpillars of the Hesperidi yet known, those of this insect construct nests to live in. "Their method of work," says Comstock, "was for each to cut a slit into the leaf from the edge, and roll the flap thus formed around its body, working from the inside of this roll, with its soft parts perfectly protected. In the garden of the Brock House, Enterprise, almost every plant was badly ragged in

this way. . . . Before transforming to a chrysalis the larva binds the leaf a little closer around itself and remains quiescent." "The full grown larva," writes Dr. Wittfeld, "in defending itself will spit out a watery greenish substance, which it throws about as it jerks its head to one side and the other."

Seasons and habits. Excepting the scanty memoranda of Abbot, nearly all the information we have upon the seasons of this insect comes from Dr. Chapman's notes made in northern Florida; from these it appears that it is double brooded and probably passes the winter in the imago state, for fresh specimens are found at the very close of the season, and a single specimen was seen by him as early as the end of March. Moreover, Palmer took old specimens the first week in March at Okeechobee, but fresh and perfect females at Indian River at the end of March. The eggs are probably laid in April and the first brood of fresh butterflies, after 45 days spent in the chrysalis (Abbot) appear at the beginning of the last week in July, become numerous after the middle of August, few and tattered before the middle of September. The butterflies of the second brood, certainly without spending so long a season in chrysalis, make their advent by the middle of September, become numerous toward the end of the month, continue so until the middle of October, and are then seen in scanty numbers until the middle of November, many of them fresh. To judge from Palmer's notes and captures there must be three broods in southern Florida, in March, (June) and August. In the Keys it flies all winter (Maynard).

Mr. Abbot says that sometimes in Georgia this species is "found frequently in oak woods and fields, near swamps." It seems to prefer the blazing rays of noonday sun. Maynard speaks of the butterflies as swiftly flying and restless, but they would appear to be less powerful than *Epargyreus*, since they were seen by Mr. Lowell Elliot to be vigorously attacked and driven away from *Salvia* flowers by that impetuous creature; and Comstock writes of them: "Their flight is not remarkably quick, and I have taken them in my hand while engaged in feeding on a plant."

Desiderata. The exact distribution of this insect, which has undoubtedly been confounded with others ever since the days of Linné, needs the most careful study; it is unquestionably more widely spread than shown on our map. The condition in which this insect passes the winter is undetermined, the number of broods in different parts of the country not carefully made out; descriptions of the flight and postures of the butterfly and observations on the duration of the chrysalis are also desirable, as well as fuller account of the habits of the caterpillar.

LIST OF ILLUSTRATIONS.—EUDAMUS PROTEUS.

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| <p><i>General.</i>
Pl. 27, fig. 4. Distribution in North America.
<i>Egg.</i>
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47: 1. Scales of the male imago.
57: 5. Side view of head and appendages enlarged, with details of the structure of the legs.</p> |
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EPARGYREUS HÜBNER.

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| <p>Epargyreus Hübner, Verz. bek. schmett., 105 (1816).</p> | <p>Goniloba pars Auctorum.
Eudamus pars Auctorum.
<i>Type.</i>—<i>Papilio tityrus</i> Fabr.</p> |
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There through the long, long summer hours,
The golden light should lie,
And thick young herbs and groups of flowers
Stand in their beauty by.
The oriole should build and tell
His love tale close beside my cell;
The idle butterfly
Should rest him there, and there be heard
The housewife bee and humming-bird.

BRYANT.—*June*.

Imago (58: 1). Head (61: 14) very large, clothed with short, equal hairs arranged to a considerable extent in transverse, scarcely appressed ridges, and with a slender, tapering, slightly curving pencil of stiff hairs, from the outer base of the antennae projecting over the eyes and about one-fourth their semi-circumference in length. The whole of the front projecting a little and equally beyond the front of the eyes, a little more full across the middle than elsewhere, but not forming a transverse ridge; the margin of the sides is rounded, and scarcely reaches the middle of the front of the antennal bases, the front and hind border straight, and the former longer than the latter; it is nearly or quite twice as broad as long. Vertex almost flat, nowhere reaching the level of the eyes, about as long as the front, meeting it by an impressed, straight sulcation, connecting the middle of the antennal bases, and separated from the occiput by a slightly impressed, slightly arcuate line, obsolete laterally, its concavity forward. Eyes large, full, more broadly rounded behind than in front, naked. Antennae inserted with their hinder edge scarcely behind the middle of the summit in slight pits, their interior bases separated from each other by nearly twice the diameter of the base of the antennae; exclusive of the crook, one-fourth longer than the abdomen, composed of thirty-seven joints, of which the last thirty form the club, which is a little less than half as long as the very slender stalk, and bent a little beyond the middle, at about the forty-second joint; the basal half or a little more than that of the straight portion of the club is regularly incrassated, so as to be thickest at about the thirty-fourth joint, and there scarcely equals in thickness the length of three consecutive joints, then tapers again very slightly, the crook continuing the regular diminution in size, and ending in a bluntly pointed tip, the whole club subcylindrical; the longest joints of the stalk are four times as long as broad, and the crook is generally recurved at a little less than a right angle. Palpi very short and exceedingly stout, yet not nearly so stout as in Eudamus, a little longer than the eye, heavily clothed with long and erect scales, beyond which the apical joint, clothed only with recumbent scales, scarcely projects; the basal joint is globose, the anterior part of its tip greatly produced anteriorly and upwards, so as almost to embrace the base of the middle joint; the middle joint ovate, regular, two and one-half times longer than broad, and

as many times longer than the basal joint, the apical joint very small, cylindrico-ovate, twice as long as broad, and half as long as the breadth of the middle joint, directed a little forwards. Prothoracic lobes almost entirely aborted, scarcely discernible; patagia much as in *Eudamus*.

Fore wing (: 2) long, triangular, rather more than twice as long as broad; costal margin nearly straight, but gently and almost equally sloping at the two extremities, the apex sub-rectangular; outer margin bent at the independent vein at a very broad angle, nearly straight above and below it, scarcely protuberant at the submedian nervure; inner margin straight, barely and very broadly excised in the middle, bent at a general angle with the outer margin of about 115° . Costal margin thickened for nearly half its length; costal nervure terminating directly above the lower extremity of the cell; superior subcostal nervules hugging the nervure in their proximal portion; the first arising opposite the base of the second median nervure, at three-fifths the distance from the base to the apex of the cell; the others as in *Eudamus*, the apex of the wing being continued between the nervure proper and its last superior branch; inferior subcostal nervule as in *Eudamus*; first median nervule originating very close to the base of the wing at about one-fourth the distance to the origin of the second branch; cross vein closing the cell obsolete excepting at its extremities, slightly less oblique than the margin of the wing, striking the median nervure directly beneath the origin of the third superior subcostal nervule; about midway between this and the base of the second median nervule is the origin of an otherwise obsolete reversed shoot, extending to the centre of the cell; cell about seven times as long as broad, and nearly five-sevenths the length of the wing; internal nervure as in *Eudamus*, excepting that the tip of the vein becomes diffused and lost before reaching the submedian.

Hind wing subtriangular; costal margin very strongly arcuate at the base, beyond very gently arcuate; the outer margin very full in the subcostal region, excepting for the submedian lobe considerably and pretty regularly arcuate; the lobe dentiform, broader than long, well rounded on the inner side, excised at the base on its outer side; inner margin gently and faintly concave. Costal, precostal and subcostal nervures as in *Eudamus*; space inclosed between the costal and subcostal at base smaller, and the two veins completely amalgamated at their point of separation; subcostal forking at a little less than one-third way to the margin and connected with the median nervure by an obsolete arcuate cross vein, less than half as far beyond the second divarication of the median as that is beyond the first; submedian nervure straight, hardly separated from the nervure on either side of it; internal nervure almost marginal.

The scales enclosed in the costal fold of the male include a very long and slender spatula and a rod-like bristle with apical flagellum.

Legs 2, 3, 1; tufted as in *Eudamus*, but the upper surface of the hind tibiae much more thinly; femora 2, 1, 3, tibiae 2, 3, 1, tarsi 3, 2, 1; fore coxae very long and most profusely furnished exteriorly with long hairs; fore and hind femora of equal length, middle femora nearly one-third as long again; fore femora with a row of profuse long hairs along the posterior inferior edge, shortening apically. Fore tibiae two-thirds as long as fore femora, and more than half as long as middle and hind tibiae; these equal, the middle pair a little shorter than the middle femora, the hind tibiae one-fourth longer than the hind femora. Leaf-like appendage long and slender, originating in the middle of the apical four-fifths of the tibia, surpassing its extremity a little, fully four times as long as broad, a little arcuate, especially on its apical half, which tapers regularly to a point; middle and hind tibiae with an apical pair of long spurs beneath, the hind tibiae with a similar but shorter pair in the middle of their apical four-fifths. Tarsal joints 1, 2, 3, 4, 5; fore tarsi two-thirds as long as the middle, a little less than two-thirds as long as the hind tarsi; hind tarsi only a little longer than the middle pair; all with a triple row of slender spines beneath, longer and more erect on the middle and hind tarsi, the apical ones of each joint on all the legs considerably longer than the others; basal joint as long as the rest of the joints together on the hind and middle legs, a little longer than

that on the fore legs; second joint about two-fifths the length of the first. Claws small, slender, delicately tapering to a fine point, arcuate and bent at about right angles in the middle; pad as in *Eudamus*; paronychii compressed, conical, straight, minute.

Abdomen with the second segment twice as long as the first and half as long again as the third, beyond decreasing regularly in length; the eighth segment of the male is longer at the sides than the seventh, but strongly and roundly excised in the middle above. The centrum of the upper organ of the male appendages is a little compressed, tumid, regularly arched; hooks slender, about half as long as the centrum, independent, nearly parallel and horizontal, meeting at their blunt tips the extremity of the independent lateral arms, which are nearly straight, similar to the hooks but longer; clasps large, scarcely at all convex, tapering strongly to an upturned point, the upper edge furnished a little beyond the base with an upturned, slender, prominent lobe.

Egg. Subglobular, slightly broader than high, well rounded, broadest in the middle of the lower three-fifths, the upper part regularly domed; furnished with a considerable number of distinct but slight and equal vertical ribs, half of them extending from the base to the micropyle, the others just failing to reach it. They are cut and the interspaces traversed by exceedingly fine and close cross lines, forming with the vertical ribs quadrangular cells. Micropyle small.

Caterpillar at birth. Head large, subglobose, twice as high as deep, well rounded, each hemisphere with a slight independent arcuation above. Body nearly uniform, the first thoracic segment largest; the dorsal shield inconspicuous. Several longitudinal series of club-shaped bristles, one-tenth as high as the breadth of the body, arranged in longitudinal rows as follows: a laterodorsal anterior row on the thoracic segments; a supralateral anterior row on the abdominal segments; and on all the segments a post-central lateral row, an anterior suprastigmatal row, and a substigmatal series, the last with one in advance of the middle on all the segments, and also one behind the middle on the abdominal segments.

Mature caterpillar. Head subglobular, the sides moderately and regularly arcuate, the lower curve of the head slightly less arcuate, each hemisphere with a slight independent arcuation of its own above; the suture between rather deeply impressed; the inner frontal triangle half as high again as broad, reaching barely to the centre of the head; head of equal height and breadth, half as high again as its greatest depth, which is below; the front receding rapidly above as seen on a side view; collar narrow, of the width of the head; the surface of the head is covered with a reticulation of granular tubercles which are less conspicuous on the front than elsewhere; the frontal triangle with a distinct median carina and the lower portion of the front with wavy striae converging toward the mouth parts; ocelli six in number, four arranged in a regularly arcuate row, the convexity forward, equidistant or the two upper slightly approximated, the fifth behind the third and as far from it as the latter is from the first counting from above, the lines uniting these three forming a right angle; the sixth situated at the outer base of the antennae in continuation of the arcuate row.

Dorsal shield of the first thoracic segment not very conspicuous, well arched longitudinally, but tapering forward, occupying the posterior half of the segment and reaching on either side nearly to the spiracles; posteriorly ridged, and on either side next its lower extremity dimpled. Body elongate, tumid, of nearly equal size on the first six abdominal segments, in front and behind which it tapers toward either extremity, in front perhaps more rapidly than behind; the last segment well rounded with a not greatly expanded anal flap. Abdominal segments divided into a large anterior section equal to about a third of the whole and four subequal posterior sections each of which shows a tendency to subdivide again, being thickened anteriorly and posteriorly. The surface is covered with very scattered, minute, conical papillae, higher than broad, each supporting a very short, straight, tapering, apically open, hyaline bristle; there is also a laterodorsal series of crateriform annuli in the middle of the broad anterior section of all the segments, on the thoracic, however, occurring in the

middle of the entire segment or in case of the first segment in the middle of the dorsal shield; there is a similar laterostigmatal series in the same position on all the segments both thoracic and abdominal; a stigmatal series just in advance of the stigmata or the position where they would be, on the thoracic segments; an infrastigmatal series larger than the others placed a little in advance of the spiracles on the abdominal segments, the crater of each annulus being occupied by a thin pellicle presenting the appearance of a glistening drum; a ventrostigmatal series on the abdominal segments a little behind the spiracles; these last two series are represented on the first thoracic segment by a pair of similar subconfluent annuli midway between the spiracle and the base of the leg; all of these crateriform annuli are more readily seen in the caterpillar of the fourth stage than in the mature form. Sternal gland of the first thoracic segment with a transverse slit between the lips of which may be thrust a coral-red mamillate process thickly studded with conical hyaline projections on either side of a transverse sulcation. Legs with a basal fleshy portion, stout; the other parts small, tapering, appressed; the claws very fine, strongly beveled, sharply pointed; prolegs large at base, rapidly tapering, blunt at tip, with a reniform circle of numerous outward curving hooks in a triple row, the hooks strongly arcuate, gently tapering, rather bluntly pointed. Described from blown specimens.

Chrysalis. Very stout; head and prothorax forming together a scarcely perceptible sub-rectangular mass as viewed from above, the front angulato-arcuate, the lateral angles rounded; the median third of the front with a scarcely independent prominence, the whole a little more than twice as broad as long, slightly narrower in front than behind, separated from the prothorax by a distinct though slight sulcation, scarcely more than half as wide as the widest part of the body; mesothorax slightly broader than long, of nearly uniform breadth between the basal wing tubercles and the abdomen, in front of the former sloping rapidly to the much narrower prothorax; basal wing tubercles very blunt, being scarcely more than the angulation of the body; viewed from above the body increases in width posteriorly to the abdomen which has an independent enlargement, being largest at the third segment (the broadest part of the body), beyond which it tapers conically to the cremaster; viewed from the side the curve of the anterior half of the body is scarcely affected by the thoracic sulcation, the mesothoracic curve being very gentle and equal in front and behind; beneath the bluntly and regularly rounded head there is an angulation, the lower surface beyond very regularly arched but with the wings more protuberant than in *Eudamus*. The position of the mandibles marked by a distinct, warty prominence on either side of the base of the tongue. Prothoracic spiracles large, forming the third of a circle, the posterior lip obsolete, guarded by a very broad, dense mass of exceedingly short bristles which leave but a small, circular opening not a quarter the size of that in *Eudamus*; their outer extremities not surpassing the outer limits of the prothorax, so that when viewed from above the antennae are seen outside of them. Hind legs and antennae as in *Eudamus*, as also the carina of the movable abdominal segments. Abdominal segments beyond the seventh entirely amalgamated, showing no sign of sutures, except that faintly indicated by the coloring. Preanal button composed of a low, pinched, pyramidal, lateroventral prominence, the two sides connected together by a strong, arcuate ridge and supported anteriorly by an expanding, lateroventral ridge which fades out before reaching the seventh abdominal segment, and on the sides by a looped ridge or thickening, open posteriorly, and whose lower apical angle is separated by a sulcation from the highest point; posteriorly it connects with the lower outer sides of the cremaster proper, between which inferiorly the cremaster is broadly sulcate. Cremaster preceded above at the base on the ninth abdominal segment by a stout, transverse ridge as broad as it and which descends rapidly to its base; cremaster a little shorter than the fifth to seventh abdominal segments together, as viewed from above triangular, excepting for the produced quadrate apex; deeply sulcate behind this quadratic portion in a triangular, depressed field; viewed laterally, it is gently arcuate and tapers slightly to a truncate tip which, and which only, is armed with the hooklets; these do not essentially differ from those of *Eudamus*.

This is a purely American genus, tolerably well supplied with species, and apparently confined mostly to the northern tropics, with the exception of the single species described below, and which extends east of the Rocky Mountains, as far north as the St. Lawrence.

The butterflies of this genus are among the largest of Hesperidae, and have the anal angle of the hind wings prolonged into an obtuse rounded lobe, instead of the tails of the previous genus. The wings are very dark brown, and the front pair furnished with yellow, vitreous, irregular markings, mostly arranged in a transverse band crossing the wing from the middle of the costal margin toward, and nearly to, the anal angle; there are also a few very small spots in a transverse series near the apex; the hind wings are devoid of markings above, but beneath are provided with a very large spot of irregular shape, often pure silvery white, generally having more or less the form of a broken band, crossing the middle of the wing transversely.

The history of our own species alone is known; in the north this is single brooded, wintering as a chrysalis, and flying in June and July. The butterflies frequent open spots, are exceedingly vigorous, and have an astonishingly rapid flight, vying with that of the hawk moths. All the wings are raised in repose. The eggs are laid singly, and the caterpillars, which feed on Leguminosae, and sometimes injure locust trees by their ravages, live singly and sluggishly, in nests formed of leaves connected by bands of silk. The chrysalids are suspended at both extremities in cocoons either made from the leaves of the tree, or upon or near the ground of any chance substance.

The eggs are vaulted and furnished with a moderate number of longitudinal ribs, extending their whole length. The caterpillars are plump and cylindrical, or a little depressed, tapering toward either extremity, with a strongly constricted neck and a very large head; they are green, ornamented with transverse stripes of yellow or green. The chrysalids are dusky, stout and well rounded, but otherwise possess slight distinctive characters, though they have an unusually subdued prothoracic spiracle.

EXCURSUS LIV.—ODD CATERPILLARS.

Full of strange shapes, of habits, and of forms,
Varying in subjects.

SHAKESPEARE.—*Love's Labour's Lost*.

Let's talk of graves, of worms and epitaphs.

SHAKESPEARE.—*King Richard II*.

CATERPILLARS of *Pieris rapae* are green, cylindrical worms, and it is a not uncommon supposition among the uninformed that such is the case with all caterpillars, except that they may differ in being hairy or spiny.

But not all caterpillars are green, nor do all have a uniform cylindrical shape; on the contrary, there are among them, and perhaps especially among the caterpillars of butterflies, many odd and striking forms. Among our butterflies, perhaps there are none so strange in appearance as the caterpillars of *Basilarchia*, which have some of the segments greatly hunched and bear knotted tubercles of varying lengths, which the attitude of the creature, with the front part of the body arched and the hinder part raised aloft, renders specially prominent; then, too, the colors, green, and cream color and dark brown, mixed in an extraordinary manner, heighten the strange appearance; so that, one seeing it for the first time might well exclaim, "What sort of creature is that?"

A similarly blotched caterpillar is seen in the great *Heracles* *eresphontes* of the orange trees; and we have in our own fauna not a few other striking caterpillars, striking at least in their colors, such as the not altogether dissimilar *Anosia* *plexippus* and *Papilio* *polyxenes*, so far apart in their actual structure; each of them is green, transversely marked with narrow stripes of black, in each the head is banded vertically with black, and like many caterpillars of such gay attire, both live in unusually exposed positions. Among our spiny caterpillars of the *Nymphalinae*, we have two which are transversely banded, this time with black and orange,—*Euphydryas* *phaeton* and its near neighbor, *Cinclidia* *harrisii*; these, too, are all the more striking that they are frequently found in numbers in more or less open colonies. Then there are the *Argynnis*, rarely seen, some of which have the front coriaceous filaments of the body of exceptional length; in none is this the case to such a degree as in *Euptoieta* *claudia*, where they are clubbed at the tip and where in addition the body is strongly striped with highly contrasting colors.

Of quite a different character are the caterpillars of *Euphocaes* and *Jasoniades*, which when full grown, are green, greatly swollen in front, and bear upon either side of the middle of the swollen portion ocellate spots of great brilliancy and beauty; while, to see the full beauty and striking nature of the markings of these caterpillars, one must needs use a magnifier, when the turquoise-blue spots, arranged in rows down the back, will be brought more fully to view. When one calls to mind that if we tickle one of these creatures with a feather, it will, in alarm thrust a pair of brilliant red or orange fleshy forks from out a slit behind the head, one will have to look far to find anything quite so striking and unexpected to the ordinary observer. Or, again, look for the first time at the caterpillar of *Epargyreus* *tityrus* with its great head, strangulated neck and transversely banded lemon green body, and the two great orange spots, like monstrous eyes, on either side of the head, and one wonders, indeed, when shown into what a butterfly it will transform. The caterpillars of *Laertias* *philenor* are of quite another type; here the whole side of the body, as well as a portion of its upper surface, is fringed with rows of long

fleshy filaments, often orange colored in whole or in part, in vivid contrast to the velvety black body.

The head, as the only corneous portion of the whole creature, is not unfrequently adorned with horny ornaments of a peculiar kind; thus the caterpillars of *Polygonia* have each hemisphere of the head crowned by a long spine bearing subsidiary spinules and whorls round the summit; the caterpillars of *Basilarchia* a great round knobbed tubercle, and those of *Chlorippe* seem to wear an Elizabethan frill of spines around the whole posterior part of the head. In some, as in *Satyrodes* and *Enodia*, each hemisphere of the head is prolonged to a long conical point, which the caterpillar presents to fullest view when at rest by bending its head over upon the face and leaving these horns, which naturally rise erect, extending straight forward; to match them, the hinder extremity of the body bears an enormous pair of similar horns, extending straight backward, while to add to the effect the body is striped with colored bands uniting the horns of the two extremities. We have mentioned but a few, and not all even of the most striking of our caterpillars, limiting ourselves to our own fauna, to show that even in such a narrow field one may find many curious forms.

EPARGYREUS TITYRUS.—The silver-spotted hesperid.

[White-spotted skipper (Gosse); locust skipper butterfly (Packard); silver-spotted skipper (Maynard).]

Papilio tityrus Fabr., Syst. entom., 532 (1775);—Smith-Abb., Lep. ins. Ga., 37-38, pl. 19 (1797);—Abb., Draw. ins. Ga. Brit. Mus., vi: 66, figs. 86, 87 (ca. 1800).

Hesperia tityrus (pars) Abb., Draw. ins. Ga., Gray coll. Bost. soc. nat. hist., 58 (ca. 1800);—(pars) God., Encycl. meth., ix: 716, 743 (1819).

Eudamius tityrus Boisdu-LoC., Lép. Amér. sept., pl. 72 (1833);—Agass., Class. ins., 8-14, pl. fig. 1-23 (1850);—Emm., Agric. N. Y., v: 215, pl. 38, figs. 4, 5ef (1854);—Gosse, Alab., 86 (1859);—D'Urb., Can. nat., v: 240 (1860);—Harr., Ins. inj. veg., 3d ed., 310-312, fig. 133, 134, pl. 5, fig. 1 (1862);—French, Rep. ins. Ill., vii: 163 (1878);—Butt. east. U. S., 374-377, fig. 80 (1886);—Middl., Rep. ins. Ill., x: 98 (1881);—Coq., ibid., 153 (1881);—Pack., Bull. U. S. ent. comm., vii: 100 (1881);—Aaron, Pap., iv: 26-30 (1884);—Mayn., Butt.

N. E., 52-53, pl. 6, figs. 73, 73 a (1886).

Goniloba tityrus Westw.-Hew., Gen. diurn. Lep., ii: 512 (1852);—Lucas, Sagra, Hist. nat. de Cuba, 632 (1857);—Morr. Syn. Lep. N. Amer., 112 (1862).

Telegonus tityrus Butl., Catal. Fabr. Lep. 263 (1869).

Thymele tityrus Kirlb., Syn. catal. Lep., 571 (1871).

Epargyreus tityrus Scudd., Syst. rev., Amer. butt., 49 (1872); Butt., 107, figs. 63-65, 91-93, 172, 180, 191 (1881).

Gonuris tityrus Burm., Rev. mag. zool., 1875, 54 (1875).

Papilio clarus Cram., Pap. exot., i: 66, 152, pl. 41, figs. E. F. (1779).

Epargyreus clarus Hübn., Verz. schmettt., 105 (1816).

Figured also by Glover, Ill. N. A. Lep., pl. 1, fig. 15 (3 figs.); pl. 29, fig. 2, ined.

Alles, was von dir mir kam,
Sterbendank' ich dir es jetzt:

Alle Lüfte Mergenzug,
Dem ich sommerlang gehobt,
Alle Schmetterlinge Flug,
Die um mich im Tanz geschwebt.

Rückert.—Die sterbende Blume.

I go, I go; look how I go,
Swifter than arrow from the Tartar's bow.
SHAKESPEARE.—*Midsummer-Night's Dream*.

Imago (♂: 8; ♀: 3). Head covered above with dull, tawny-tipped, dark brown scales and hairs: the tuft on either side of the antennae black, supported at base by

tawny yellow hairs; beneath varying from tawny buff to yellowish brown and behind the eye a slender rim of pale yellowish scales; palpi similar to under surface of head, but near the apex becoming largely infuscated by brownish and blackish fuliginous or dark reddish brown scales of which the apical joint is mostly composed; longer blackish bristles are found on the exterior half of the palpus; above, the palpus resembles the upper surface of the head. Antennae above blackish brown, tinged often with dark olivaceous, on the crook and apical half of club with purplish reflections; beneath pale greenish yellow with a nacreous lustre, shading into dusky on the basal half of the stalk; anterior surface of crook and extremity of club naked and rather pale castaneous. Tongue piceous, tip mahogany brown.

Thorax covered above with dull tawny brown hairs having an olivaceous tinge. Beneath with blackish purple hairs with some yellowish or tawny ones. Femora dark brown with a purplish tinge; tibiae and tarsi dull brown above, elsewhere clay yellow or buff; foliate appendage of fore tibiae glistening brownish yellow; spurs dull yellowish tipped with very dark red; spines dusky reddish; claws the same, deepening toward the tip; pad dusky.

Wings above dark chocolate brown, occasionally tinged with very dark olivaceous, and on the basal half, particularly below, covered extensively with very dark tawny hairs. *Fore wings* provided with such hairs more profusely next the base than beyond and they seldom extend over more than one-third of the wing; crossing the middle of the wing in a line drawn from the middle of the basal four-fifths of the costal margin to the extremity of the submedian nervule is a broad, irregular, unequal band of amber yellow, the scales erect, occasionally tinged in places with orange and extending from the costal margin to or just beyond the middle of the medio-submedian interspace; the nervures crossing it are delicately marked with brown; its interior border is more regular than its exterior, running at nearly right angles with the costal border with a slight, or occasionally considerable, bow, its convexity inwards, to the middle of the basal two-thirds of the lower median nervule; where the band crosses the cell, its width is nearly or quite twice that of the latter, its exterior border passing in an irregular line, in general parallel to the interior border, from the costal margin (at the extremity of the costal fold in the ♂) to the base of the upper median nervule; it resumes its course at a little within the middle of the basal two-thirds of the middle median nervule and crosses the lower median interspace, usually sinuously, at right angles to the nervules; the termination of the band consists of a smaller, usually triangular or subtriangular spot, its apex downwards, and the middle of its base at the limit of the exterior border of the upper part of the band; occasionally, however, the interior edge of the spot is in continuation with, or even outside of, the exterior margin of the band; a small, transversely quadrate, occasionally slightly arcuate, similarly colored spot crosses the middle of the basal two-thirds of the upper median interspace; and beyond, as far from the band as that from the base of the wing are three quite small, white or pale yellow, subfenestrate, quadrate spots in the successive interspaces below the third superior subcostal nervule, the upper two longitudinal (the uppermost usually the largest), in a line at right angles to the costal margin, the lower square or transverse, its interior border on a line with or slightly beyond the exterior border of the upper two. The costal fold of the ♂ filled with glistening, brownish yellow scales and hairs. Fringe slightly darker than the wing, especially at the nervure tips, its outer half, at least below the subcostal area, broadly interrupted with pale brownish yellow or dull white. *Hind wings* provided with the tawny hairs more conspicuously and extensively than the fore wings, but they are less frequent on the outer third of the wing and above the cell; they are also supplanted by longer dark brown hairs next the inner margin and often along the principal nervules of the outer half of the wing. Fringe of the color of the wing, darker at the nervure tips and below the middle of the medio-submedian interspace, above which it is interrupted apically as in the fore wings.

Beneath blackish brown with a castaneous or vinous tinge, the hind wings slightly darker than the fore wings. *Fore wings* with the markings of the upper surface exactly

repeated beneath, the apical half of the cell less heavily clothed with scales than the other dark parts of the wing, and the outer margin, above the lower median nervule, for the depth of about an interspace, but more broadly in the median interspaces than above, paler than within and also flecked, not profusely, with vitreous scales having a purplish reflection and giving the border a hoary appearance; occasionally the whole wing, and especially the upper half, is very distantly and very inconspicuously flecked with ochraceous scales; inner border as far as submedian paler than the ground color; fringe pale ochraceous, broadly interrupted at the nervure tips with blackish fuscous, which is most distinct in the middle, being usually overlaid on the basal third by ochraceous.

Hind wings more uniform in tint than the front pair, being equally clothed throughout; ochraceous scales are, however, sometimes sparsely scattered over all but the central parts of the wing, although often confined to the base; in the centre of the wing is a large, transverse, crystalline, snow white spot, sending towards the costal border a usually continuous, rather narrow spur of the same; the main portion of the spot is subtriangular with the angles well rounded. Its broadest portion extending from just beyond the first divarication of the median to the middle of the basal four-fifths of the upper median nervule and limited above by that nervule on the outer half, but on the inner encroaching a little on the cell; the lower rounded extremity or apex of the triangle reaches fully to the middle of the lower half of the medio-submedian interspace, fully as far from the outer border as the entire width of that interspace; the exterior limit of the spot is slightly concave, with a slight bend at the middle median nervule; the interior border is arched a little; from the middle of the upper side or base, the spot extends as a nearly equal bar with straight sides to the upper subcostal nervule, following the direction of the vein which closes the cell and which runs through its middle; the bar is usually between one-fourth and one-third as wide as the base of the spot from which it arises and in the subcostal interspace has often a rounded projection toward the base; from the upper exterior angle of this bar a moderately slender bar or lunule, only its interior edge distinctly defined, traverses the costo-subcostal interspace, but is often separated from the broader bar to a slight extent. Beyond the band thus formed is a slender, transverse, powdery stripe of scattered whitish or yellowish scales subparallel to the outer margin but more distant from it above than below, crossing the upper median nervule at its middle and extending from the upper subcostal to the submedian nervule; it is often wholly or partially obsolete; the outer border of the wing is more or less broadly flecked with vitreous scales having a paler purplish or violet reflection, between the upper subcostal and lower median nervules; usually this belt occupies the width of an interspace in the middle and tapers a little above and below, giving this portion of the wing a hoary appearance; the inner margin as far as the submedian nervule is more or less tinged with very dull olivaceous and nearly concealed by long hairs of the same color; above the middle of the medio-submedian interspace the fringe resembles that of the fore wings, below this it is nearly of the ground color of the wing.

Abdomen above very dark purplish brown, the tips of the segments narrowly and inconspicuously red, the whole basal half partially concealed by long tawny olivaceous hairs; beneath blackish brown flecked with long fulvous scales becoming brownish toward the base and at the segment tips narrowly and inconspicuously red; hairs at the extremity of the abdomen dark brown, but beneath a little yellowish; upper organ of male appendages (35: 36) with the hooks continuing downward like the posterior curve of the centrum, united at base, but divergent, at tip a little incurved, their blunt extremity with a scarcely perceptible inferior inclination; lateral arms approximating a little and in their apical half a little expanded; a little larger than the hooks but otherwise similar. Clasps more than twice as long as the breadth of the base, the basal half broad and bearing above an elevated obovate lobe, a third as high as the breadth of the clasp at its base and having between it and the base of the clasp a deep rounded excision; beyond it the clasp tapers rapidly half way to the tip, then becomes nearly parallel and terminates in a produced pointed apex subdentate on its upper edge, directed upward and backward and curved slightly inward.

Measurements in millimetres. Length of tongue, 16-18 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	21.5	26.5	29.5	24.25	29.	30.6
antennae.....	11.	13.9	14.35	12.25	14.	14.4
hind tibiae and tarsi..	8.55	11.35	12.4	9.15	11.75	12.5
fore tibiae and tarsi..	6.2	6.75	7.5	5.25	7.	7.6

Described from 17♂, 10♀.

Buffused aberration. *EPARGYREUS TITYRUS OBLITERATUS*. Mr. Roland Thaxter has given me a remarkable male of this species taken near Boston. It measures but 23 mm. in length of fore wing and the only markings on the upper surface are a single very small square vitreous spot in the position of the upper of the normal preapical spots; and in place of the broad mesial band of spots, separated only by the nervures, a perfectly straight series of three subequal, equidistant, rather faint roundish spots of the normal color, one in the costo-subcostal interspace longer than broad, a quadrate larger one in the cell, and a similar, fainter, round one in the lower median interspace; they are less than a quarter of the usual size; the other two spots of the mesial series as well as the spot of the upper median interspace are wholly absent. Beneath, the same spots only are present on the fore wing, these of the mesial band larger and more distinct, with faint traces of the two missing spots. The change on the hind wing, however, is in the opposite direction: the minute spot at the base of the cell is present and the mesial band, perhaps less intensely silvery than usual, is very broad; its exterior border runs in a vaguely sinuate course subparallel to the hind border, but a little nearer to it below than above, from the middle of the outer two thirds of the costal to the middle of the outer third of the submedian nervure, beyond which a few scales are scattered along the nervure toward the margin of the wing; the interior border of the band extends between the same nervures from the middle of the basal two-thirds of the costal to and beyond the first divarication of the median, with a deep indentation in the upper part of the cell nearly to its tip. The upper part of the band is thus double the usual width.

Accessory sexual peculiarities. The costal fold of the fore wing of the male encloses two sorts of scales: one a rod-bristle (47:11b) of extreme tenuity, about .025 mm. long, and very delicately flagellate at tip; the other an attenuated, very slenderly lanceolate, spatulate-tipped scale (47:11a) with a granular structure, generally a little longer than the rod-bristles, which is about their longest, but varying greatly in length, some being less than half as long as others. Perhaps minute, peg-like androconia may have been overlooked.

Egg. Furnished with from sixteen to nineteen vertical ribs, which are of equal elevation throughout, every alternate one running from the extreme base nearly or quite to the micropylar basin, which is about .15 mm. in diameter, the others stopping a little short of it near the middle of one side of the dome; at their widest these ribs are .2 mm. apart; the interspaces are crossed by very delicate, straight, transverse lines, .02 mm. apart, breaking the interspaces up into quadrangular cells, about ten times as broad as high; these lines as they cross the ribs cut them so as to give them a beaded or denticulate appearance. Color of egg grass green. Height, .68 mm.; width, 1.04 mm.

Caterpillar. *First stage* (73:8). Head (80:19) black-brown, nearly orbicular, slightly subcordate, with a few white or colorless hairs; mouth parts nearly black. First segment slightly dingier than the rest of the pale greenish yellow body, with a faint testaceous indication of the coming shield, easily overlooked. Legs and prolegs of color of the body. Length, 2.5 mm.; breadth, .4 mm.; length of bristles, .04 mm.

Second stage. Head round, piceous, with white hairs; third joint of antennae black, bristle white. Mouth parts blackish red. First thoracic segment dull vinous, with a large, broad, black, dorsal shield, rounded at the sides. Rest of body dull greenish yellow from the contents of the intestine, with prolegs and legs, including claws, of same color, the front pair of legs a little infuscated; hairs few, short, definitely dis-

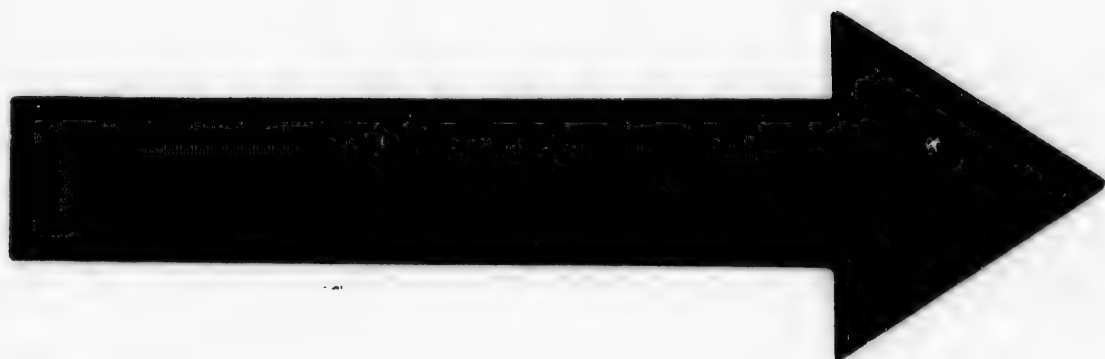
posed, colorless; spiracles scarcely distinct from general color, slightly testaceous. Length, 5.5 mm.; breadth of body, 7 mm.

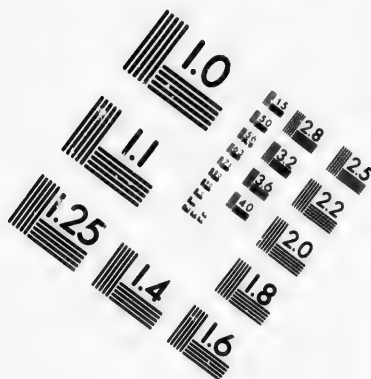
Third stage (76: 35). Head (80: 20) uniform black brown, minutely scabrous, covered with a short, dense pile of simple hairs. Mouth parts and ocelli the same. Body dark green above, marked, in narrow, transverse stripes, with yellowish green; below yellowish green; sometimes the yellowish green predominates above, and in all cases the darker color is made less conspicuous by being broken by frequent dots of the paler color. The body is shining and is covered densely with very short pile, composed of apically expanding bristles, .06 mm. long and .02 mm. in diameter at tip; first segment black above, bordered anteriorly with dull reddish fuscous; beneath reddish flesh-colored; the last two segments are greenish yellow, marked faintly with pale orange along the outer border. Stigmata greenish fuscous, that of the first thoracic segment blackish. Legs pale reddish, apical half fuscous; other legs pale yellowish green, apical half tinged with fuscous; prolegs pale yellowish green, anal pair yellowish. Length when full grown, 12 mm.; breadth of body, 2.5 mm.; of head, 1.8 mm.

Fourth stage. Head (80: 21) dark livid brown or brownish ferruginous, shining, but dulled by being completely sprinkled with low, granulate, equidistant tubercles, which form part of a reticulate vermiculation covering the whole surface, the granulations wanting on the lower part of the head, which is striate by converging lines toward the mouth parts; median suture blackish, impressed, the large, round, bright orange spot sometimes more or less lemon color on the lower part of the sides of the front, directly in front of the ocelli, which limit it and indeed infringe upon it behind; ocelli vitreous, with piceous annuli at the base; mandibles blackish ferruginous; labrum luteo-castaneous, darkest apically; basal joint of the antennae pale, the long third joint castaneous; posterior mouth parts luteo-castaneous. Collar and dorsal shield of first thoracic segment nearly of the color of head, the latter a little lighter but posteriorly infuscated or even becoming blackish; rest of the first thoracic segment, together with the entire ventral surface of same, including the first pair of legs, coral-red; the second and third pairs a paler red. Body bright sulphur-yellow, alternating with numerous transverse lines and narrow streaks of a blackish color; many of them irregularly interrupted, sometimes almost obsolete, but there remains always an infralateral series of short, velvety black dashes on the middle of the anterior section of each segment, together with a slenderer, suprastigmatal streak, spot or dot in the same part of the segment; a faintly traced, interrupted, mediodorsal, infuscated line, sometimes obsolete, often dilated into a more distinct dot, when the markings are most conspicuous, connected with the oval, infralateral spot. Spiracles black. Ventral prolegs bright orange yellow, the anal pair concolorous with the body. Length of body, 27 mm.; breadth of body, 4.5 mm.; of head, 4.5 mm. Described from blown specimens and the MS. notes of Dr. Asa Fitch.

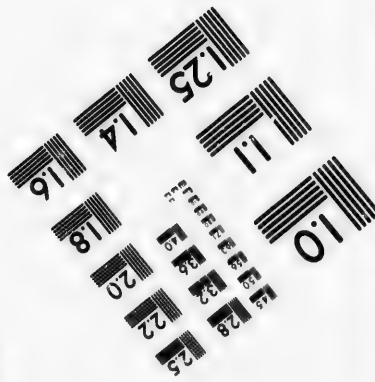
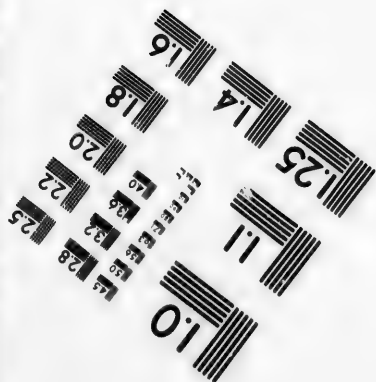
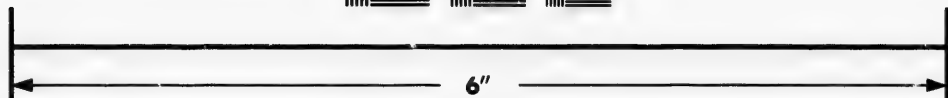
Last stage (76: 30, 31, 33). Head (80: 22) dark brownish red, delicately scabrous and clothed with short pile; between the ocelli and the labrum a large, roundish, bright orange spot. Ocelli vinous in a black field; basal joint of antennae pale, beyond black; mandibles black; other mouth parts paler; labrum blackish.

Body greenish yellow marked with transverse lines, blotches and dots of grassy green, the lines encircling the body above, the blotches being abundant on the sides and the dots forming a transverse row on the anterior edge of each segment. Collar just behind the head, dark brownish red; first thoracic segment orange red; the shield browner and its hinder edge distinctly infuscated; last segment greenish, rimmed posteriorly with yellow; beneath dark green dotted with yellow excepting the first segment which is red. The body is densely covered with exceedingly short, fine hairs. Spiracles velvety black, bordered with pale green; second and third thoracic segments, but especially the former, marked with black in the place where the spiracles would be if there were any. Legs orange red, the front pair brightest, the claws infuscated. Prolegs greenish, all but the anal pair marked externally with transverse bands of pale orange. Length, 37 mm.; breadth of body, 6.25 mm.; of head, 5 mm.; of collar, 2.25 mm.





A resolution test chart featuring various patterns of horizontal and vertical lines of increasing frequency. Each pattern is accompanied by a numerical value indicating its resolution. The values include 1.0, 1.1, 1.25, 1.4, 1.6, 1.8, 2.0, 2.2, 2.5, 2.8, 3.2, 3.6, 4.0, 4.5, 5.0, 5.6, 6.3, 7.1, 8.0, 9.0, 10, 11.2, 12.5, 14, 16, 18, 20, 22.5, 25, 28, 32, 36, 40, 45, 50, 56, 63, 71, 80, 90, 100, 112, 125, 140, 160, 180, 200, 225, 250, 280, 320, 360, 400, 450, 500, 560, 630, 710, 800, 900, 1000, 1120, 1250, 1400, 1600, 1800, 2000, 2250, 2500, 2800, 3200, 3600, 4000, 4500, 5000, 5600, 6300, 7100, 8000, 9000, 10000, 11200, 12500, 14000, 16000, 18000, 20000, 22500, 25000, 28000, 32000, 36000, 40000, 45000, 50000, 56000, 63000, 71000, 80000, 90000, 100000, 112000, 125000, 140000, 160000, 180000, 200000, 225000, 250000, 280000, 320000, 360000, 400000, 450000, 500000, 560000, 630000, 710000, 800000, 900000, 1000000, 1120000, 1250000, 1400000, 1600000, 1800000, 2000000, 2250000, 2500000, 2800000, 3200000, 3600000, 4000000, 4500000, 5000000, 5600000, 6300000, 7100000, 8000000, 9000000, 10000000, 11200000, 12500000, 14000000, 16000000, 18000000, 20000000, 22500000, 25000000, 28000000, 32000000, 36000000, 40000000, 45000000, 50000000, 56000000, 63000000, 71000000, 80000000, 90000000, 100000000, 112000000, 125000000, 140000000, 160000000, 180000000, 200000000, 225000000, 250000000, 280000000, 320000000, 360000000, 400000000, 450000000, 500000000, 560000000, 630000000, 710000000, 800000000, 900000000, 1000000000, 1120000000, 1250000000, 1400000000, 1600000000, 1800000000, 2000000000, 2250000000, 2500000000, 2800000000, 3200000000, 3600000000, 4000000000, 4500000000, 5000000000, 5600000000, 6300000000, 7100000000, 8000000000, 9000000000, 10000000000, 11200000000, 12500000000, 14000000000, 16000000000, 18000000000, 20000000000, 22500000000, 25000000000, 28000000000, 32000000000, 36000000000, 40000000000, 45000000000, 50000000000, 56000000000, 63000000000, 71000000000, 80000000000, 90000000000, 100000000000, 112000000000, 125000000000, 140000000000, 160000000000, 180000000000, 200000000000, 225000000000, 250000000000, 280000000000, 320000000000, 360000000000, 400000000000, 450000000000, 500000000000, 560000000000, 630000000000, 710000000000, 800000000000, 900000000000, 1000000000000, 1120000000000, 1250000000000, 1400000000000, 1600000000000, 1800000000000, 2000000000000, 2250000000000, 2500000000000, 2800000000000, 3200000000000, 3600000000000, 4000000000000, 4500000000000, 5000000000000, 5600000000000, 6300000000000, 7100000000000, 8000000000000, 9000000000000, 10000000000000, 11200000000000, 12500000000000, 14000000000000, 16000000000000, 18000000000000, 20000000000000, 22500000000000, 25000000000000, 28000000000000, 32000000000000, 36000000000000, 40000000000000, 45000000000000, 50000000000000, 56000000000000, 63000000000000, 71000000000000, 80000000000000, 90000000000000, 100000000000000, 112000000000000, 125000000000000, 140000000000000, 160000000000000, 180000000000000, 200000000000000, 225000000000000, 250000000000000, 280000000000000, 320000000000000, 360000000000000, 400000000000000, 450000000000000, 500000000000000, 560000000000000, 630000000000000, 710000000000000, 800000000000000, 900000000000000, 1000000000000000, 1120000000000000, 1250000000000000, 1400000000000000, 1600000000000000, 1800000000000000, 2000000000000000, 2250000000000000, 2500000000000000, 2800000000000000, 3200000000000000, 3600000000000000, 4000000000000000, 4500000000000000, 5000000000000000, 5600000000000000, 6300000000000000, 7100000000000000, 8000000000000000, 9000000000000000, 10000000000000000, 11200000000000000, 12500000000000000, 14000000000000000, 16000000000000000, 18000000000000000, 20000000000000000, 22500000000000000, 25000000000000000, 28000000000000000, 32000000000000000, 36000000000000000, 40000000000000000, 45000000000000000, 50000000000000000, 56000000000000000, 63000000000000000, 71000000000000000, 80000000000000000, 90000000000000000, 100000000000000000, 112000000000000000, 125000000000000000, 140000000000000000, 160000000000000000, 180000000000000000, 200000000000000000, 225000000000000000, 250000000000000000, 280000000000000000, 320000000000000000, 360000000000000000, 400000000000000000,



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Chrysalis (85: 22, 25, 26). The chrysalis is dark brown, marked with blackish and with testaceous; sometimes the whole chrysalis is testaceous marked profusely with irregular fine lines of brownish black in creases; these markings, however, are usually confined to the pterothecae and back, the rest of the body being darker; sometimes the whole front of the appendages between the wings is black; the thoracic spiracle (87: 11) is very broadly lined posteriorly with an equal, velvety, prominent, semicircular band; the surface of most of the body is quite smooth, but the dorsum of the mesothorax is transversely and finely wrinkled, and the fifth to seventh abdominal segments bear a broad but sharp carina in the middle encircling the whole body, the posterior slope of which is more abrupt than the anterior; the ninth segment bears above a waved, blunt, median, transverse carina, and below, a short, prominent, blunt, straight, median carina, terminating at either end in a tubercle at the base of the cremaster; cremaster (87: 1) stout and transverse at the base, hollowed above and below, long, rapidly tapering, curved downward in its apical half, terminating in a little, thickened, blunt, transverse extremity, which is furnished with numerous hooks, projecting in every direction from the tip and having their points turned in every direction; these hooks are very long and slender, strongly sinuate, the pedicel slightly curved near base and tip, its tip slightly thickened, the hook incrassated from the pedicel on and bluntly pointed, strongly curved and almost coiled. Whole about .15 mm. long, the curve of the hook .05 mm. broad, the thickest part of the hook .1 mm. broad.

Geographical distribution (27: 5). This butterfly has a wide distribution, being a member equally of the Carolinian and Alleghanian faunas and occurring in the southern half of the United States from the Atlantic to the Pacific. It is found in abundance on the shores of the Gulf of Mexico and in Florida it reaches at least as far as the St. John's and Indian Rivers (Palmer) but has not been reported from the southern half of the peninsula. In the south-west, Hulst states that it is the most abundant of all butterflies in southern California and Arizona. Aaron found it abundant in southern Texas, and it extends beyond our borders in various parts of Mexico to Yucatan (Aaron) and the island of Puna, Ecuador (Eugenies Resa). Aaron even states that he has seen a single specimen from the upper Amazons, so that it probably follows the backbone of the continent to this point.* In our own country, on the Pacific coast, it occurs in the greater part of California at least as far north as San Francisco (H. Edwards), but it does not seem to occupy the elevated central plateau excepting at its southern extremities, as in Arizona already mentioned, the southern part of Utah, Mount Trumbull and Spring Lake Villa (Palmer), and central Colorado, as at Engelmann and Platt Cañons (Snow) and South Park (Mead); but to the east it occurs as far north as Fort Niobrara, Neb. (Carpenter) and Heart River Crossing, Dak. (Allen), though east of this in the northernmost part of the Alleghanian fauna it begins to become infrequent. It is said to be common in Wisconsin by Hoy, but it is "not common" in southern Michigan (Harrington). In Ontario it is common at St. Catherine's (Beadle) and at Hamilton, "one of the most abundant species" (Moffatt), but was not found at London by Saunders, and Reed reports but two specimens as ever having been taken

*Mabille says that there are two specimens in the Brussels Museum from Guiana!

there. Lowe reports it from Essex County. It is found at Montreal (Bowles) and is even stated to be common there by Caulfield; it occurs at Ottawa (Fletcher), is reported at Chateauguay Basin, and a single specimen has been taken at Quebec (Bowles).

It is a tolerably common, sometimes abundant, species in the three southern New England States, occurring even in such elevated places as Andover (Sanborn), Shirley (Scudder), Mount Toby (Sprague), and Williamstown, Mass. (Scudder); north of this it becomes rarer, having been taken only in New Hampshire at Milford "plenty" (Whitney), Dover (Faxon), Walpole, a single specimen (Smith) and a few at Plymouth (Scudder); and in Maine a single specimen at Norway and a few at Hallowell (Miss Wadsworth).

Haunts. The butterfly may usually be found about gardens where it is attracted at mid-day by flowers. Mr. Lintner has found it about lilacs, Miss Coggeshall noticed it constantly alighting on the "Prince's feather" (Higginson) and I have often noticed its attraction by the butterfly-weed, *Asclepias tuberosa*; Mr. Lowell Elliot also speaks of its swarming in Central Park, N. Y., about the flowers of *Salvia splendens*, and it has been caught in a lady's slipper, *Cypripedium spectabile*. Mr. Allen, however, found it in groves in Iowa rather than in the flower-bedecked prairies; all the specimens brought home by him, however, were females and may have been in search of locust trees.

Food plants. Like the caterpillar of the preceding species, this larva feeds on a number of papilionaceous Leguminosae; the following are known: false indigo, *Amorpha fruticosa* Linn. (Chapman, Riley); common locust, *Robinia pseudacacia* Linn. (Harris and others); clammy locust, *R. viscosa* Vent. (Abbot, Harris); rose acacia, *R. hispida*, which it seems to prefer to *R. pseudacacia* (Sanborn); *R. neomexicana* in southern California (Hulst); American Wistaria, *Wistaria frutescens* DeC. (Gosse, Chapman, Edwards); bush clover, *Lespedeza capitata* Michx. (Lintner); marsh vetchling, *Lathyrus paluster* Linn. (Hamilton); and ground nut, *Apios tuberosa* Moench. (Chapman). I have taken it on many of the above, and am inclined to think that *Robinia hispida* is its commonest food in New England; I have also found the larva in abundance in the Botanic Garden in Cambridge on *Desmodium marylandicum* Boott, on which no one appears to have noticed it, and found it also in Amherst Notch in great numbers on *Desmodium nudiflorum* DeC. and *Amphicarpaea monoica* Ell. They freely eat *Desmodium canadense* and *Gleditschia*. As these plants are widely distributed among the different tribes it is highly probable that it may feed on any papilionaceous Leguminosae.

Habits of the caterpillar. When it is very young, and until it has arrived at its third stage, the caterpillar constructs a nest by nearly severing from one side of the leaf a small roundish piece and folding it over, so

that the under surface of the fragment is uppermost; this roof is kept in place by long silken strands attached to the edges of the fragment and the surface of the leaf beyond, in such a way as to arch the roof, like a dome; the pieces cut in this manner are irregular in form, and vary from 5 to 13 mm. in diameter; the edges of the roof are from 2 to 5.5 mm. above the leaf. When older it attaches two leaves in a similar manner, fluting the edges by attaching to them silken cords at short distances so as to dome the upper leaf considerably (82:11). In this way these caterpillars, says Harris (Ins. Inj. Veg., 311-312),

form a kind of cocoon or leafy case to shelter them from the weather, and to screen them from the prying eyes of birds; although there may be and often are, many of these caterpillars on the same tree and branch, yet they all live separately within their own cases. One end of the leafy case is left open and from this the insect comes forth to feed. They eat only or mostly in the night and keep themselves closely concealed by day. These caterpillars are very cleanly in their habits and make no dirt in their habitation, but throw it out with a sudden jerk so that it shall fall to a considerable distance [often several yards]. . . . The viscid locust tree is sometimes almost completely stripped of its leaves by these insects, or presents only here and there the brown and withered remains of foliage which has served as a temporary shelter to the caterpillar.

Abbot says that sometimes "for greater safety from birds" (?) the nest is made in the leaves of another plant in close proximity.

In a single night, one nearly full fed caterpillar placed among fresh leaves spun silk, apparently in a vain effort to construct a nest, over a dozen or more leaves, and extended threads from one point to another, one of which was 32 mm. long and very strong; but besides all this work it ate large pieces out of six different leaves, devouring even the ribs—in all a quantity equal to two leaflets of the common locust. The caterpillar when disturbed moves its head from side to side with spasmodic starts, its black jaws wide open and snapping at everything brought into contact with them. After moulting it devours the cast off pellicle, excepting the head-shell. I have never found it feeding except at night.

I formerly stated that the caterpillar had a musky odor; but discovered later that the odor supposed to have come from them came from some half dried *Gleditschia* leaves in the box where they were feeding. Reed states that the deserted nests of the caterpillar are sometimes used as hiding places by the beetle, *Cyllene pictus*, which seem "to enjoy the cool retreat thus provided for them from the heat of the sun." Mrs. Mary Treat says that while *Formica sanguinea*, in common with other ants, greedily seeks for the caterpillar of *Eurymus* and carries many to its nest, "all species of ants turned away . . . apparently in great disgust," from caterpillars of *tityrus* offered to them.

Cocoon and pupation (86: 26; 87: 12). Harris remarks in his account of this insect (loc. cit.) that "they frequently transform to chrysalis within the same leaves which have served them for a habitation, but

more often quit the trees and construct in some secure place a cocoon of leaves or fragments of stubble, the interior of which is lined with a loose web of silk." Specimens reared in captivity made their cocoons by drawing together leaves of locust so as to form a smooth oval cavity within; the leaves were attached by short threads so as to present no opening large enough to look within; the whole interior was lined with a thin web of silk similar to the carpet which the larva of *Euphoeades troilus* stretches across the leaf of a sassafras tree. Within the cavity the caterpillar spun two Y-shaped threads whereon the chrysalis was eventually suspended; that at the hinder extremity had the stem about 6.5 mm. long, the forks each 4.5 mm. long and diverging at an angle of about 75° , their tips being 6 mm. apart; at the junction of the threads the hooklets of the tail of the chrysalis were plunged into the silk; the other Y struck the mesothorax of the chrysalis, which rested with its back in the loop; the angle of the forks was slightly less but the forks themselves were longer, being 11-12 mm. in length and 12 mm. apart at their tips. Measurement of the shrouds of another cocoon formed in leaves gave the following result: the stem of the thoracic Y was 5 mm. long, the two limbs 9 mm. and 11.5 mm.; the stem of the anal Y was 8.5 mm. long; the two limbs 3.5 and 4.5 mm.

Mr. Angus found large numbers of the cocoons of this insect underneath boards, shingles and rubbish lying on and about a heap of saw dust beneath some large locust trees, and in the place of the particles of earth, straw, leaves, etc., with which cocoons formed on the ground are usually covered, they were coated with saw dust. "The greater portion of them," says Mr. Angus, "were found between shingles and the boards to which they were nailed; we cut some shingle roofs up for fire wood and I was astonished at the quantity of pupae which were found; some of the crevices in which they had hidden were scarcely larger than the chrysalis and in these instances, shingles above and boards beneath served for two sides of the cocoon. They are frequently found under boards that are left lying flat on the ground and in this case the cocoon is generally very slim—sometimes barely enough to secure the chrysalis to the board." Mr. Angus has always found them in "some secluded crevice, either in a stone wall, board fence, under boards or such situation; they are generally found in a horizontal position, but this probably depends somewhat on the position of the crevice."

These saw-dust cocoons (82: 9) form a rather regular ovate mass about 35 mm. long and from 15 to 18 mm. broad; the cavity within is barely more than large enough to contain the chrysalis and is lined with a thin tissue of brownish silk, delicate as a spider's web but very tough and strong; a strand of dirty whitish silk, parted above, is stretched up and down one extremity of the cavity where it is 8 mm. in diameter, and in this the tail of the chrysalis is plunged; the Y-shaped thread for the support of the thorax has a stem 4 mm. long and less than half as thick as

the thread at the tail end; the forks which are 8.5 mm. long seem to be as thick as the stem—perhaps because less tightly woven—are attached to the sides of the cocoon a little below the middle, and are 14 mm. apart, thus differing considerably from the cocoons formed of living leaves; apparently there is no spreading of the threads at their attachments; the silk of which they are formed seems to be whiter than that of the walls of the cocoon, and is in no way imbedded in the integument of the chrysalis.

The several changes in the external form and character of a butterfly in passing from the larval to the pupal state have nowhere been so carefully stated as by Agassiz in his description of this insect in a paper not often quoted, so that I transfer his remarks on the subject almost bodily:—

The first marked modification from its former condition consists in a general shortening of the body. The whole larva contracts for about one-third of its length, and thus assumes permanently a position which it shows sometimes when at rest. But even after it has thus become quiet, it will, when disturbed, again move about in search of a more protected shelter.

If left undisturbed, the body is seen to swell, especially in its anterior part, which seems to be in a state of chronic inflammation, as it were, having the appearance of an oedematous swelling, distended by a considerable accumulation of lymph.

The thoracic region and the head are at this time the chief seats of the formative process, and of a more active process of nourishment; the other parts seeming rather to wither, the skin to shrivel, and the prolegs to dry up. Indeed, before long, the skin of the larva is sufficiently loose to be separated without much difficulty from the pupa forming underneath; and by watching carefully the moment when the skin splits upon the back in the process of being naturally removed, the whole process may, with some assistance, be accelerated, and the skin turned away before the chrysalis is entirely formed. At this moment the young animal presents characters so different from the perfect pupa, that, unless the whole process has been carefully watched, no one would suppose that the forms it then exhibits are really the next transformation of the larva towards its change into a chrysalis.

Indeed the chrysalis, when perfect, presents a hard case, upon which, with some attention, we may distinguish the outlines of the abdominal joints and the thorax; upon the sides of this, and below it, an outline of the future wings may be recognized, as well as superficial indications of the legs underneath, bent backwards between the wing covers; there is likewise a tubular flattened case, representing the antennae; and upon the middle line, a similar one answering to the proboscis. All these parts are soldered together, and upon the skin itself, so closely as to be entirely immovable, and to appear rather as a protecting envelope of the organs, the form of which they foreshadow, than as these organs themselves. Nevertheless, if we carefully watch the process of the last moulting, or, rather, if we are successful in removing gently the larva-skin before the pupa is hardened, we see that all the above mentioned organs exist in reality, wholly independent and entirely free from each other, though still imperfectly developed, since the legs are mere cylindrical tubes without regular articulations; since the antennae present a similar tubular appearance, somewhat swollen towards the end, but without joints; since the maxillae project as two independent tubes, also very much like another pair of legs; and since the wings appear as four distinct, swollen, but somewhat flattened vesicles, identical in appearance with the lateral respiratory vesicles of Annelides, sufficiently large, however, to remind us of the wings as they appear when the perfect insect has come out from the chrysalis. We have, therefore, an apparently complete butterfly, somewhat imperfect in its characters, coming out from the larva with all its parts independent, prior to the period when these parts are pressed upon the sides of the animal, and soldered with its walls.

The process by which these parts are pressed flat, and made to adhere to the body, is connected, no doubt, with the act by which the pupa escapes through the narrow slit on the back of the skin of its larva; but when the larva skin is gently removed, and the pressure prevented, these parts will all remain free, and dry up in an irregular connection, and shrivel in an irregular fusion. Or if, immediately after the removal of the larva skin, the young animal be placed in water with a few drops of alcohol, the parts will remain expanded, and may afterwards be preserved in that condition in a stronger liquid. So that we may derive imperfect butterflies directly from larvae, sufficiently similar to the butterfly which escapes from the pupa to be readily recognized, and presenting all the characters of the perfect butterfly, except the imperfect articulations of the legs and antennae, the unconnected maxillae, and the vesicular wings. . . .

When the metamorphosis of the larva is allowed to go on undisturbed, this immature butterfly, with a comparatively long abdomen, still further contracts. The abdomen especially is considerably shortened and thickened, though its joints remain movable. But the head and thorax and all their appendages are soldered together, and form a solid, immovable case; and the connection of the external appendages becomes so intimate, that, instead of appearing like independent parts, they assume rather the appearance of outlines of those organs carved upon a surface, as if they were mere indications of the parts to be developed in these regions, but seeming to be as yet unformed. Nevertheless, as I have shown above, they were all independent shortly before, and have become gradually more and more united in the perfect pupa. (Class. ins. embryol. data, 11-13.)

Life history. This butterfly is single brooded in the north, double brooded in the south, and in both regions hibernates as a chrysalis. In the south the butterflies first appear in the latter part of March and continue to emerge from the wintering chrysalids for at least a month, and to fly for certainly a month longer; the members of the second brood are consequently emerging from chrysalids from the middle of June probably until the middle of August, and they continue on the wing until at least the end of September. In the north the butterflies usually make their appearance during the first week in June, but not unfrequently as early as the 22d or 24th of May, even toward the northern limits of its range; indeed the earliest record in the northern states is the earliest above mentioned, at Milford, N. H. (Whitney); they usually become abundant by the middle of June and continue to emerge from the chrysalis until the very end of the month, although by this time they ordinarily become uncommon in the southern parts of New England; they continue, however, to fly until the end of July or the first week of August. The eggs, which are deposited singly, are first laid about the middle of June, sometimes by the end of the first week, and the females are still ovipositing at the middle of July and undoubtedly until August; they hatch, according to French, in about four days; the caterpillars may be found fully grown between the middle of July and the end of September when the last have gone into winter quarters and changed to chrysalis. Mr. Angus writes of a chrysalis which disclosed the imago while in his hand, about the middle of August; this individual was unquestionably from caterpillars of the same year, and may, perhaps, be considered as an accidental phenomenon; yet possibly it

is in about this latitude (New York City) that the second brood begins to make its appearance, for in the same connection, writing on August 17, Mr. Angus says: "the second brood are now flying around; I noticed the first of this brood about eight or ten days ago." So, too, Mr. F. H. Sprague has taken good specimens about Boston at the end of July and during the first three weeks of August, which may indicate the occasional appearance here of the second brood of the south.

Habits, flight and postures. Were it not for the propensity of the butterfly for flowers it would be difficult to capture, for it is the most vigorous of our butterflies. It has a dashing, impetuous flight, starting with a plunge and stopping as abruptly; it startles the collector by its sudden advent, bewilders him by its unexpected dashes, and then vanishes like a swift arrow. When two meet they circle around each other with amazing rapidity, soaring higher and higher with apparently increasing celerity, keeping always one or two feet from each other; suddenly one darts off in a straight line and the other whisks away in an opposite direction. Gosse bears similar testimony, saying (Lett. Alab., 61): "it is very susceptible of alarm, flies swiftly, violently and in a headlong manner, and has many of the motions of the hawk-moths." It is also a pugnacious creature, attacking with rude vigor any insect, especially of a large size, which may seek to share with it the flowers it delights in. Gosse, on a later page, adds:—

I have bred very many butterflies and have universally found them, on first opening the dark box in which they had been evolved, perfectly still, and making no attempt to escape when touched with the fingers; but these skippers formed a singular exception. Before the lid was half raised, all was scuffle and flutter within, the first intimation I had of their birth; though as I had examined them every day, I knew by the discoloration of the pupa that the change was near. Before I could catch a glimpse of anything within, one dashed out like lightning, and if I had not shut the box, the other would have followed as quickly.

On account of this liveliness of disposition and strength of wing it is difficult to capture a specimen without danger of its being greatly defaced in its struggles to escape.

Upon alighting after flight, the wings are held upright, each in a perpendicular position, and therefore, since the body is stout, not tightly closed; the folded inner margin of the hind wings is continuous with the upper edge of the abdomen, and the costal edge of the same pair reaches the middle of the lowest median interspace of the front wings. When at complete rest, the wings are also held erect but are compressed, and the legs, widely spread, bring the body to the surface. The antennae are on a plane with the whole body (the head being elevated), nearly straight when viewed laterally, the club drooping; viewed from above, they curve outward a very little near the base, and diverge at a right angle. They are held in a similar manner just after alighting, but the club scarcely droops

and the divergence varies from 90° to 120°. When walking, the wings are held as after settling, and the antennae diverge at right angles, the club turned a little outward.

Enemies. In 1848 Dr. Harris bred *Ophion bilineatus* (88:8) from this insect; it stings the caterpillar and makes its exit from the chrysalis late in June. Riley has taken *Pteromalus puparum* (89:1-2) in the act of laying its eggs on the caterpillar, and I have found a nest occupied by the cocoon of another hymenopterous parasite of medium size, probably a *Limneria*, Mr. Howard thinks, which left the caterpillar nothing but skin and head in its penultimate stage; according to Harris it is also attacked by a dipterous parasite, a species of *Acroglossa*, to which he gave the name of *Tachina hesperidarum*; it was bred by him from the chrysalis in spring and specimens, considered by him the same, were taken on thistles July 22 by Rev. Mr. Leonard, of Dublin, N. H. Gentry says that the white-eyed Vireo, *Vireo noveboracensis*, feeds upon the perfect insect.

Desiderata. The principal point requiring investigation in the history of this insect is the number of broods in the New England states. Is there always a second brood? and is there possibly a third in the south? It has been claimed that forms found in the extreme south, and until recently regarded as distinct, should be looked on as at most varieties of this species, and therefore the earlier stages of both forms in the south should be carefully compared. The egg is insufficiently described. This common species would be the best to study in trying to learn the office of the ranged crateriform annuli of the caterpillars of Hesperidae.

LIST OF ILLUSTRATIONS.—EPARGYREUS TITYRUS.

General.

Pl. 27, fig. 5. Distribution in North America.

88:8. *Ophion bilineatus*, a parasite.

89:1. *Pteromalus puparum*, ♂, a parasite.

2. Same, ♀.

Caterpillar.

Pl. 73, fig. 8. Caterpillar at birth.

76:30, 31, 33. Mature caterpillars.

35. Caterpillar, third stage.

80:19-22. Front views of head, stages I, III-V.

82:11. Nests.

Chrysalis.

Pl. 82, fig. 9. Cocoon.

85:22, 23, 26. Chrysalis, side views.

86:26. Shrouds for the attachment of the cremastral hooks.

Pl. 87, fig. 1. Cremastral and cremastral hook.

11. Side view of front end, showing

thoracic spiracle.

12. Cocoon and chrysalis.

Imago.

Pl. 9, fig. 8. Male, both surfaces, colored.

15:3. Both surfaces.

35:36. Male abdominal appendages.

41:2. Neurulation.

47:11. Scales of male imago.

58:1. Side view of head and appendages enlarged, with details of the structure of the legs.

61:14. Front view of head, denuded.

ACHALARUS SCUDDER.

*Achalarus** Scudd., Syst. rev. Am. butt., 50
(1872).

Eudamus pars Auctorum.
Gonoloba pars Auctorum.

Type.—*Popilio lycidas* Smith-Abb.

Let me smell the wild white rose,
Smell the woodbine and the may;
Mark, upon a sunny day,
Sated from their blossoms rise,
Honey-bees and butterflies.

JFAN INGELow.—*A Dead Year*

(57:1). Head very large, clothed with moderately short hairs, arranged in transverse, somewhat appressed ridges, the most conspicuous one connecting the antennal bases; a very short, thick, appressed, nearly straight bunch of bristly hairs projects a little way beyond the rest at the exterior base of the antennae, directed outwards; front considerably and almost uniformly tumid, surpassing somewhat the front of the eyes; the corners are largely rounded off, the front border straight and emarginate; the hind border between the middle of the antennae straight and scarcely sulcated; less than twice as broad as long. Vertex nearly flat, very slightly and gently tumid, almost equalling the height of the eyes, longer than the front, separated from the occiput by a deep, brace-like, scarcely impressed line. Eyes large, full, very nearly round, naked. Antennae inserted with the hinder edge in the middle of the summit, in slight pits, their interior bases separated from each other by a little less than twice the diameter of the antennal base; exclusive of the crook about one-third longer than the abdomen, composed of 49 joints of which 26 form the cylindrical club, which is about half as long as the stalk and bent somewhat beyond the middle at about the 34th joint; the club increases very gradually in size at first with scarcely any diminution in the length of the joints, is longest from the 27-31st joints and is nearly as broad as the length of two joints, diminishes in size very gradually, but a little more rapidly in the apical half of the attenuated portion and ends in a blunt tip, about three-fourths the diameter of the stalk and scarcely broader than the length of the joints; in the middle of the stalk the joints are a little more than three times as long as broad and the crook is strongly recurved at less than a right angle. Palpi very short and very stout, a very little longer than the eye, heavily clothed with long and erect, elongate scales, beyond which only the tip of the apical joint, clothed with recumbent scales only, projects; the basal joint is globose, the tumid projection of the anterior inner portion of the apex giving it a subpyriform appearance; the middle joint is tumid, cylindrical, obovate, straight, two and one-half times longer than broad, the ends similar, the apical joint minute, ovate, nearly half as long again as broad and its length contained about two and one-half times in the breadth of the middle joint, directed forwards.

Prothoracic lobes closely resembling those of *Eudamus*, nearly as long as the shorter diameter of the eye. Patagia large, well rounded, the posterior lobe long but not slender, more than half as broad as the base, scarcely three times as long as broad, the basal half equal, the apical half tapering a little, the tip very bluntly pointed, the whole piece nearly as long as the breadth of the head.

Fore wing (41:5) triangular, much less elongated than in the preceding genera, being but little more than half as long again as broad; costal margin gently arcuate, but flattened along the middle; the outer margin moderately arcuate in its upper half, below nearly straight; the upper third bent at scarcely less than a right angle with the outer half of the costal margin; the outer margin is not produced at the submedian nervure; the anal angle is well rounded and the inner margin barely concave, and of

* α- χαλάρος, one by no means languid.

about the same length as the outer margin. Costal margin thickened through most of its basal half; costal nervure terminating but little before the apex of the cell; the outer but not the inner superior subcostal nervules sinuate at the base, the first arising opposite the second median nervure, almost at the middle of the outer half of the cell; the fourth at the outer extremity of the cell and running to the tip of the wing; the second much nearer the first than the third, and the latter nearer the fourth than the second; first inferior subcostal nervule bent strongly at its extreme base, the basal portion subobsolete, arising directly opposite the fourth superior subcostal nervule, obliquely; first median nervule arising just beyond the middle of the basal half of the cell; the nervure united to the angle of the inferior subcostal nervule by a cross vein, obsolete excepting at its extremity which runs parallel to the outer margin; close to this originates the subobsolete, arcuate, recurrent nervule which runs toward the centre of the cell; cell about six times as long as broad and a little more than two-thirds the length of the wing; internal vein much as in *Eudamus*, but nearly lost before reaching the submedian.

Hind wings rounded, triangular, scarcely longer than broad; the base of the costal margin with a strongly arcuate lobe; the margin itself beyond the angulation very gently arcuate; the outer margin very full, strongly convex, scarcely crenulate, bent at scarcely more than a right angle with the inner margin at the tip of the submedian nervure, with a scarcely perceptible, broad, angulate excision at the tip of the lower median nervule; inner margin bent with a broad angle at the tip of the internal nervure; costal, precostal and subcostal nervures much as in *Epargyreus*, but with a broader lacuna at the base and with the costal nervure less strongly arcuate beyond it; subcostal nervure forking at more than one-third the distance to the margin; no perceptible cross vein closing the cell, but the subcostal and median nervures angulated slightly just beyond their last divarication; first submedian nervule arising some distance before the forking of the subcostal.

Scales enclosed in the costal fold of the male similar in general to those of *Thorybes*.

Legs 2, 3, 1; all the femora tufted beneath with a compressed fringe of hairs, decreasing in length from the base toward the apex, those of the hind and middle legs very long at the base; hind tibiae fringed thinly above. Femora 2, 1, 3; tibiae 2, 3, 1; tarsi 3, 2, 1; fore femora scarcely longer than the hind; middle femora half as long again as the front pair. Fore tibiae a little more than half as long as fore femora; hind tibiae scarcely shorter than the middle pair, scarcely longer than the fore femora. Leaf-like appendage small and slender, originating in the middle of the outer two-thirds of the tibiae, five times as long as broad, straight, tapering toward the tip to a blunt point; middle and hind tibiae with an apical pair of spurs, the hind tibiae with a similar pair in the middle of the apical four-fifths of the joint. Tarsal joints of fore leg 1, 2, 3, 5, 4; of other legs 1, 2, 3, 4, 5; fore tarsi a little less than four-fifths as long as the middle, and two-thirds as long as the hind tarsi; all with a triple series of slender spines beneath, the apical ones of each joint much longer than the others; basal joint as long as the rest together on the fore and middle legs, a little shorter on the hind legs. Second joint about two-fifths the length of the first. Claws small, very slender, delicately tapering to a fine point, strongly arcuate or bent in the middle; pad pretty large, transverse, paronychla apparently aborted.

Abdominal appendages of the male having the upper organ scarcely compressed, regularly arched, hooks much as in *Eudamus*; lateral arms forming a sheath which reaches but little beyond the base of the hooks. Claspers large, broad, a little convex, the upper edge developing an exceedingly large, rounded lobe, directed upward and a little backward, the clasp beneath and beyond it forming an arcuate ribbon, with an apical curved spine.

Egg. Bee-hive shaped, broadly truncate above, largest in middle of basal half, narrowing below very rapidly and then very broadly truncate, a fourth broader than high, the sides with delicate, very slightly elevated, distant, vertical ribs, extending from base to summit, and passing slightly over the rim; interspaces cut by numerous very regular and faint transverse raised lines; summit with a network of broadly transverse, large, polygonal cells, becoming abruptly minute on the micropyle rosette.

Caterpillar at birth. Head much as in *Epargyreus*, very delicately punctate and striato-punctate. Body uniform, much narrower than the head; prothoracic shield large, covering almost the entire segment, and including the spiracles; segments divided into a broad anterior and four subequal, narrow, posterior sections, each of which bears transversely a row, the anterior three rows, of scarcely raised, sub-conical, dot-like papillae; several longitudinal rows of bristles, of unusual length and slenderness, very delicately forked at tip, mounted on minute papillae arranged thus: on the middle of the anterior large section a laterodorsal series, slightly more approximated on the thoracic than on the abdominal segments; a central or posterocentral infralateral series on the anterior of the four short sections, at a similar height on all the segments, or scarcely higher on the thoracic; an anterior supraglignatal series on the middle of the anterior broad section, one to a segment, higher than this, double and two to a segment on the thoracic segments; an infrastigmatal series having one on the thoracic and a pair on the abdominal segments. The posterior segment has some incurved hairs slightly longer than the others, but none that are recurved. Besides the bristle-bearing papillae there is a row of infrastigmatal annuli just above the anterior infrastigmatal bristles.

Mature caterpillar. Head orbicular, scabrous, pilose, the occipital suture narrowly impressed, the summits of the hemispheres crowned with a few denticles posteriorly; triangle very slender, much higher than broad; labrum broadly and roundly emarginate; mandibles massive. Ocelli subequal, the four anterior in a slightly arcuate row, equidistant, the posterior forming almost exactly the centre of the circle, of which the others form an arc. Third joint of antennae slender, straight, cylindrical, slightly enlarged apically, three times as long as broad, the fourth a miniature of the third, about half as long as the breadth of the third, the bristle very long, tapering, four or more times longer than third joint.

Body plump, cylindrical, tapering forward on the thoracic, and backward and especially depressed on last abdominal segments, the latter divided into an anterior, broad, a second half as broad and three more still smaller and equal subsegments by transverse impressed lines, the first and second merging, and the third terminating, just above the spiracles; the second and third thoracic segments similarly divided into three subequal subsegments; first thoracic segment with a slender posterior chitinous shield, which fades out at, but embraces the spiracles. Body covered profusely with minute papillae, bearing very short, slightly clubbed, delicate hairs. Spiracles regularly obovate. Legs with first joint equal, compressed, second and third joints rapidly tapering, all armed beneath, apically, with spinous hairs. Prolegs very stout.

Chrysalis. In general form most resembling *Epargyreus*, but much slenderer; head and prothorax, as viewed from above, forming a quadrangular mass, with gently rounded sides, rather strongly rounded front, the middle third of which has a rounded prominence of its own, the whole about twice as broad as long, and slightly narrower than the thorax, which slopes towards it in front of the basal wing tubercle; this forms scarcely more than an angulation of the body; the thorax has much the same form as in *Epargyreus*, being slightly pinched laterally above on its hinder half; mesothorax slightly longer than broad; the body of about uniform width as far as the third abdominal segment, beyond which it tapers at first gradually, afterwards very rapidly to a conical tip; viewed laterally the mesothorax is pretty regularly arched, with a more rapid descent in front than behind; the prothorax a little sunken, the anterior extremity of the body with a blunt, parabolic curve; the abdomen is at first equal, afterwards conical. Mandibular plate smooth; prothoracic spiracles large, broadly semi-lunate, with protuberant, flaring, posterior lip, which is fluted excepting at the edge itself; the whole faces forward and is filled, excepting a tolerably large and circular hole, with a mass of short filaments; posterior legs and antennae reaching the same point at about the end of the second abdominal segment: movable segments of the abdomen with an encircling carina, as in *Epargyreus*; preanal button much as in *Thorybes*; cremaster as long as the eighth and ninth segments together, triangular, a little produced, and subequal apically, with a well rounded apex, as viewed from

above, having a moderately deep, basal, triangular depression; viewed from the side, straight in the basal two-thirds, bent slightly downward beyond, and tapering to a rounded tip; beneath deeply sulcate in the basal two-thirds; tip armed with very strongly sinuate, long and slender, equal hooklets, bearing a reversed, expanded cup, wider than long. From a specimen received from Mr. W. H. Edwards.

This American genus is composed, so far as I know, of only two species, with a similar range, whose home is the southern United States, east of the Rocky Mountains. One species extends into Mexico, the other to the southern portions of New England.

The butterflies are only a little smaller than those of the preceding genus and have a similar form, excepting that the prolongation of the hind wings is so regular as not to form a distinct lobe. The color and markings of the fore wings are either the same as in *Epargyreus* or as in *Thorybes*, but the wings are more variegated beneath, the hind wings being marmorate with transverse lines and sometimes heavily marked with dull white on the outer half.

They are double brooded in the south, but the more northern species becomes single brooded in the north, wintering in all probability in the chrysalis and flying in June. The caterpillars feed on Leguminosae and perhaps other plants, but the history of the species is not well known.

The egg is considerably broader than high, well domed, with about a dozen vertical ribs.

The caterpillars have the form of those of *Epargyreus*; the single species known is green, ornamented with a dark, mediodorsal line and slender, subdorsal, yellowish lines. The chrysalis resembles that of *Thorybes*.

*EXCURSUS LV. — VARIATIONS IN HABIT AND IN LIFE
ACCORDING TO LOCALITY AND SEASON
OF THE YEAR.*

Vor mir eröffnet sich das Buch
Der lehrenden Natur.
Ich Schüler blick' es an, und schon
Schon les' ich stammelnd Gott,

Gott in der Pracht des Schmetterlings,
Gott in der Blüte Fleiss,
Im Zwitschen der Cicade Gott,
Im Grillenleide Gott.

WIENER VERZEICHNISS.

STABILITY and instability are curiously mixed in the lives of butterflies. Observe the habits of certain kinds and you would suppose they were sensitive to the least influence from outside, scenting as it were the approach of winter from afar and making early provision for it. Winter, indeed, is the prime cause of variety in nature,—at least in the lives of animals, and hence, as already insisted on, we find in this particular much more variety in temperate regions than in the tropics. On the other hand there are

kinds—and they are pretty numerous—which act as if they had never heard of winter; this is particularly the case with polygoneutic butterflies; for it is a common thing in plural brooded butterflies to find every possible stage on the ground as winter comes on; the more the number of broods is multiplied, the more confused do the distinctions between them become; and in many cases, were the season longer, no doubt it would become quite impossible to trace them. The butterflies go on sucking honey and laying eggs, the eggs hatching, the caterpillars eating, until a heavy frost kills off all the unprepared and terminates the history of the species for the season; those of one stage survive the shock, the others die; this is the case with several of our swallow-tails and yellow butterflies and with not a few others; sometimes it is the caterpillar, sometimes the chrysalis, at others the butterfly which survives; the egg, in such cases, never.

To leap at once to the most striking case known to our fauna of a difference in habit according to the season, we would point to *Basilarchia archippus*, the caterpillar of the latest brood of which constructs from its food plant with utmost care a hibernaculum in which to pass the winter, beginning to do this long before any of the leaves of the plant show a tendency to fall, and securing the one chosen so firmly to its twig that it remains attached the winter through; yet with this common butterfly no instance has been given where a caterpillar of an earlier brood showed the remotest tendency toward such action; where two brooded, it is only alternate generations that follow this instinct, warned thereto perhaps by the growing desiccation of the food or the chill of the nights.

Winter of course intervenes to alter the mere duration of certain stages in alternate generations, as in the case of double brooded butterflies which winter as caterpillars; the wintering caterpillar suffers a torpidity of which the summer caterpillar knows nothing; but just here, in very curious contrast to the case of *Basilarchia*, we have the instances related in the text where in certain *Argynni* and probably also in some *Melitæ*ids, at the very stage of caterpillar life when in the autumn the creatures go into hibernation, the caterpillars of the summer become lethargic, sometimes remaining in this stage till lethargy merges into the dormancy of winter, sometimes awaking after a time and pursuing again the even tenor of their way.

Although it seems absurd to speak of a lethargic chrysalis, yet phenomena of precisely similar nature to this summer dormancy of the larva, and producing exactly the same result as far as the outcome of the annual history of the species is concerned, take place with some chrysalids. Thus the difference which is so common in digoneutic butterflies which winter as chrysalids, where the summer chrysalis is short lived and the winter long-lived, has the uniformity which this implies interfered with when we find

that a certain percentage, in some plural brooded butterflies advancing with the season, do not give out the butterfly when they are expected to, but keep the inmate prisoner over to another year, as though winter were already at hand; while their sisters emerge and leave progeny to take their place.

Variation in habit of another kind has been observed in the hibernation of the Pacific coast Melitæid, *Lemonias chalcon*, the habit varying with the altitude at which the creature lives; if it be high up in the mountains, the caterpillar hibernates in special webs of considerable toughness, like our *Euphydryas phaeton*; if, on the contrary, on the sun-baked plains, the caterpillars leave the webs common to their early life and crawl into the ground to hibernate.

These irregularities give a piquancy to the studies of the life histories of butterflies, for the unexpected is often happening, and even members of the same brood do not behave alike, but show an individuality which is surprising. It may thus happen that two observers following the life history of the same insect may reach very different conclusions. For as the season, and especially winter and its adjuncts, sudden and considerable changes of temperature, have much or primarily all to do with all this complexity of life, so observers at different latitudes may need to complement each other's observations to learn the whole behavior of an insect; and comparative observations north and south are highly desirable wherever any such question arises. Nothing surprised me more than to find that most of the Pamphilidi, which I had found very commonly single brooded at the north, were double or even triple brooded at the south. With us they are such slow feeders that I naturally assumed that such were their habits everywhere; but the observations of Chapman, Abbot and others prove quite the contrary.

A very considerable number of digoneutic butterflies show some variation in the numbers of the different broods, uniformly, year after year. In all such cases something disturbs the regularity of habit or uniformity of life; the lives of some are prolonged, of others hastened at special stages, and these are the butterflies whose life histories require the most careful and searching observations, continued and repeated, and the study of which is fullest of interest and significance.

ACHALARUS LYCIDAS.—The hoary edge.

[White bordered underwing skipper (Abbot); glaucous winged skipper (Maynard).]

Papilio lycidas Smith-Abb., Lep. ins. Geo., : 89-90, pl. 20 (1797);—Abb., Draw. ins. Geo. Br. Mus., xvi: 44, pl. 11 (ca. 1800).

Hesperia lycidas God., Encycl. méth., ix: 718, 751 (1819);—Morr., Syn. Lep. N. Amer. 106 (1862).

Eudamus lycidas Bois.-LeC., Lép. Amér. Sept., pl. 71 (1833);—French, Rep. ins. Ill., vii: 162 (1878); Butt. east. U. S., 370-371 (1886);—Mayn., Butt. N. Engl., 53, pl. 6, figs. 74, 74a (1886).

Gonturis lycidas Weid., Proc. entom. soc. Philad., ii: 588 (1864).

Thymete lycidas Kirb., Syn. catal. Lep., 571 (1871).

Achalarus lycidas Scudd., Syst. rev. Am. butt., 50 (1872).

Gonitoba lycidas Butl., Entom. month. mag., 56 (1870).

Proteldes lycidas Hübn., Verz. schmett., 105 (1816); Zutr. exot. schmett., iv: 10-11, figs. 621, 622 (1832).

Papilio hedysarum Abb., Draw. ins. Geo. Br. Mus., vi: 67, figs. 88, 89 (ca. 1800).

Papilionides carol. fusca Pet., Gazoph., i: 4, pl. 32, fig. 5 (1709).

Figured by Abbot, Draw. Ins. Ga., Oemler coll., Bost. soc. nat. hist. 25;—Glov., Ill. N. A. Lep., pl. 1, fig. 18 (2 figs); pl. 35, fig. 10, ined.

Hurt no living thing:

Ladybird, nor butterfly,
Nor moth with dusty wing,
Nor cricket chirping cheerily,
Nor grasshopper so light of leap,
Nor dancing gnat, nor beetle fat,
Nor harmless worms that creep.

CHRISTINA ROSSETTI.

... By day my limbs, by night my mind,
For thee and for myself no quiet find.

SHAKESPEARE.—Sonnet.

Imago (9:11). Head covered above with blackish fuliginous and brownish fuliginous scales and hairs, and a few yellowish hairs toward the sides, the scales partly concealed by a profusion of purplish hairlike scales, intermingled with which are a very few pale ones; tuft on either side of the antennae blackish brown, overlaid by yellowish white hairs at the base; beneath pale yellow, extending in a very narrow rim around the hinder part of the eye, scarcely extending above; palpi gray from a nearly equal proportion of whitish and rather pale fuliginous scales, commingled with not infrequent but slenderer blackish brown ones; on the outer side and at the extreme tip they are little more uniformly dusky, sometimes blackish, and the black bristles are frequent on the exterior half; apical joint fuliginous, flecked beneath with pale. Antennae blackish brown above, flecked a little, and especially on basal parts of the club, with pale yellowish; beneath pale dull yellowish or silvery gray, vaguely interrupted at the tips of the joints with dusky or blackish, especially anteriorly; the anterior surface of the crook and the apex of the club naked and dull, dark castaneous.

Thorax covered above and beneath with blackish brown hairs often tinged with purple and mingled with many grayish olivaceous or yellowish hairs. Legs purplish black, the femora and tibiae flecked sparsely with pale yellow scales and fringed with hairs like those of the under surface of the body; leaf-like appendage of fore legs glistening brownish yellow; tibiae and tarsal joints distinctly but rather narrowly tipped with pale scales, most heavily on the inner side; spurs pale yellowish on the surface facing the leg, blackish on the opposite; spines dark reddish luteous; spurs the same, but darker at the tips; pad dusky.

Wings above very dark brown, usually with an olivaceo-purplish tint, the fore wings generally flecked throughout very faintly and scantily with yellowish scales. Fore wings with a mesial band of five very unequal, glistening, amber colored spots, separated by the nervures only, four of which spots lie in a straight line drawn from the middle or

scarcely before the middle of the costal border to the lower outer angle of the wings, while the fifth, at the base of the upper median interspace, is triangular and wedged between the outer halves of the second and third spots, or, if subquadrate, leaves a little triangular dark spot near the middle of the band; the upper spot is small and square; the second which crosses the cell is also square or nearly so but large; the third is still larger, crossing the lower median interspace, rhomboidal, being longer than broad, while the fourth in the upper half of the interspace below is smaller than the fifth, triangular, depending by its base from the lower outer angle of the fourth; the interior margin of the upper three spots is nearly continuous, straight and at right angles to the costal margin; there is also a similar, minute, triangular or roundish spot resting upon the middle of the upper median nervule, and, a little more than half way from the mesial band to the tip of the wing, depending from the costal margin but at a little more than a right angle to the central portion of the border, is a nearly straight series of three or four minute, pale yellowish or amber colored, longitudinal or squarish spots, the lowermost a little removed beyond the others and all more or less distinctly enclosed in a blackish penumbra; the nervures are often darker than the ground color of the wing; the outer border is delicately edged with a black line; fringe pale brownish yellow, becoming paler below, the extreme base partially overlaid with dusky scales and the whole interrupted abruptly and rather broadly with blackish brown at the nervure tips. *Hind wings* with a very indistinct, broad, cloudy belt across the middle of the outer half; fringe as on fore wings but not interrupted so abruptly as there; the paler colors forming broad lunules between the dark continuations of the nervules; below the submedian and on the inner border the fringe is wholly dark.

Beneath, dark yellowish brown, freckled, tinged and striped with blackish; the mesial spots of the upper surface of the *fore wings* are repeated beneath, as also in a vague way those on the apical half of the wing; within the mesial spots the ground color is tinged with blackish; blackish freckling follows also the course of the smaller vitreous spots, and bounds interiorly a marginal series of small, grayish lunules, which increase in distinctness toward the costal margin, and are caused by a sprinkling of long white scales on a dusky ground; the inner margin is grayer than the other parts of the wing, the outer margin is narrowly edged with black, and the fringe resembles closely that of the upper surface. In the *hind wings* the ground color is nearly obscured by white and black markings; crossing the middle of the wing are two rather narrow, tortuous, subparallel black stripes, extending from the costal margin to the submedian nervure, connected in the lower median interspace, and generally just below the costal nervure, and having all but their edges uniformly sprinkled with slender, needle-like, white scales or hairs, giving the black an inky look; these bands are less than an interspace in width, run almost parallel to the outer border, are equal in width, and separated from each other by their own width, the interior edge of the outer one striking the outer divarication of the median nervure; the inner band broadens toward the costal border by extending half way to the base of the wing, between the costal and subcostal nervures; the exterior edge of the outer is vaguely defined and its border is not devoid, like the others, of the white needles; beyond the outer stripe the wing is mostly dull white above the submedian nervure, and especially in the middle of the wing, but it is flecked throughout with transverse, broken, tremulous threads of yellowish brown, which increase in frequency, breadth, and generally also in depth of tint on either side of the median area, and especially on the apical half of the white belt above this area and the middle portion of the same in the medio-submedian interspace; especially in the latter it deepens to a distinct spot; the whole inner margin is of the fundamental color, flecked with frequent, transverse, dusky threads or strigae; outer border sometimes very narrowly edged with a blackish line; fringe much as above.

Abdomen above of the color of the upper surface of the wings, the tips of the joints very narrowly paler; beneath slightly darker. Upper organ of the male appendages (35:44) with the hooks parallel, nearly straight, but slightly arcuate when viewed laterally, slender, tapering a little on the apical half, as long as the centrum, the tip

delicately uncinat; clasps much broader in the middle than at the base, by the great extension of the upper lobe, the clasp broadening to form it as far as the middle, then remaining of uniform breadth for a short distance, and then narrowing at once to considerably less than half its width, by the excision of the upper edge; the lobe thus formed is well rounded at the upper posterior angle, and rugose; beyond the lobe the narrowed clasp is regularly and pretty strongly arcuate upward, of nearly equal width, excepting a basal narrowing and a slight tapering throughout, is nearly four times as long as broad, and terminates, when directed upward, by a mass of minute prickles outwardly, and a long and slender, tapering, pointed spine, curving forward so as to touch the posterior angle of the upper lobe, and inclined at the same time a little inward.

Measurements in millimetres. Length of tongue, 15 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	20.5	21.	22.5	21.5	22.	23.
antennae.....	11.5	11.8	12.25	11.5	11.6	12.25
hind tibiae and tarsi.....	9.5	9.5	10.5		8.8	9.6
fore tibiae and tarsi.....	5.75	5.75	6.8	5.	5.5	5.85

Described from 9 ♂, 4 ♀.

Accessory sexual peculiarities. The costal fold of the fore wing of the male encloses several kinds of scales: first, a chain-bristle, flagellate at tip (47:2c) composed of from three to six links, each about .04 mm. in length; second, of rod-like, granular scales, equal except for the slightest possible spatulate enlargement at the tip, about half as long again as one of the links of the chain-bristle, and of the same relative slenderness; third, of large, thin scales, apparently of a granular structure, but really with an excessively fine striation, having various shapes, but generally long, subequal and tapering, often laterally arcuate (47:2a) and generally pointed; and fourth, the very broad, broadly truncate, almost semicircular, striate cover scales (47:2b). Perhaps minute, peg-like androconia exist, but they were not noticed at the time of examination.

Egg (66:15). Furnished with from thirteen to fifteen, generally fifteen, vertical ribs, at the most .2 mm. apart, the spaces between them broken by raised cross lines, .017 mm. apart, into quadrangular cells about ten times as broad as high; surface very finely and very faintly punctate. Micropyle rosette about .1 mm. in diameter. Color opalescent paraffine white. Height of egg, .82 mm.; greatest breadth, 1 mm.; breadth of base, .8 mm.; of summit, .4 mm.

Caterpillar. First stage (73:6). Head (80:17) subpiceous, delicately and shallowly punctate with scarcely observable striae, some arranged in confluent, vertical or subvertical rows; a few distant, curving, pellucid hairs; collar subpiceous, similarly punctate but not striate, with similar but longer hairs connected with the head by a dull reddish neck. Body green, shagreened, punctate with pale green transversely oval dots, transversely arranged on the segmental folds; papillae black on a pale green base, the hairs erect, long, straight, or slightly arcuate, pellucid green. Length of body, 3.25 mm.; breadth of same, .5 mm.; of head, .65 mm.; length of hairs, .14 mm.

Second stage. The head (80:18) becomes more pyramidal and the suture impressed above; subpiceous, covered with sparse hoary pile and above with a few conical granules. First thoracic segment and legs piceous; rest of body, other thoracic legs and prolegs greenish yellow with a ferruginous tinge to the posterior segments and all covered with white conical dots emitting brown pile; these dots form a faint row along the lateral line and there is a faint, slender, greenish, dorsal line. Under side of body paler. Length, 4 mm.; breadth of head, 1 mm.

Third stage. Summit of each hemisphere of head crowned with a transverse row of four or five triangular, pointed, depressed, forward directed, tooth-like spines; the rest of the head has become subrugose; otherwise as before. First thoracic segment castaneous with a distinct, brief, piceous shield extending only as far as the lateral line and with pallid surroundings; rest of body yellowish green, paler posteriorly, the

conical dots now lemon yellow; they form a distinct row along the lateral line, and seem to have a tendency to range elsewhere in short, longitudinal, broken lines. Dorsal line, pile, and legs as before. Length, 11 mm.; breadth of head, 1.8 mm.

Fourth stage. Does not differ from the third stage except in the size of the head (80:23) which is 2.5 mm. broad.

Last stage (76:23). Head (80:24) black, uniform, not very heavily scabrous, the rugosities having a tendency on the front to form lines converging on the mandibles; the denticles of posterior summit curved forward. Hairs uniform, short, fulvous; all mouth parts black.

Body dark green with a bluish green, moderately broad, dorsal line, the body heavily besprinkled with yellowish orange dots on and surrounding the papillae, giving it a somewhat rusty appearance; these become more orange in a narrow lateral stripe, but not in the broader and vague infrastigmatal stripe; besides, the body between the brighter dots is frequently painted in black specks, generally clustered in lines or small spots; on the last three segments the rust color is more marked; the thoracic shield is black-brown, smooth, slightly shining, with short, black, non-tapering hairs, the front edge of the segment pale blood red. Hairs of body pellucid; spiracles black with a slender, inconspicuous, testaceous annulus surrounded by a pale areola. First pair of legs black, others color of body; the claws fulvo-testaceous. Length of body, 35 mm.; breadth of body, 5.6 mm.; of head, 4.5 mm.; of first segment, 3 mm.

Chrysalis. (85:21). "Color of anterior parts whitey brown, darkest toward head, of the abdomen sordid yellow brown"; all the prominences of the head are marked with minute papillae clustered into black patches; similar black or blackish fuscous papillae are scattered irregularly and sparsely over the thorax, sparsely and with considerable regularity over the abdomen, being arranged very largely in transverse lines; each gives rise to a short "brown" bristle, mixed with some piceous ones; these bristles are stout, equal, truncate; prothoracic spiracles "black-brown, shining"; cremaster fusco-castaneous. Length, 21 mm.; breadth, 6 mm. From a specimen received from Mr. W. H. Edwards; the colors quoted after his notes.

Distribution (27:6). This butterfly inhabits most of the Carolinian and Alleghanian faunas, but becomes rare in or is absent from the extremes of both; probably its natural boundaries will be found between the annual isotherms of 50° and 68°. Petiver long ago figured it from Carolina, Abbot speaks of it as "not very common" in Georgia, Grote found it at Demopolis, Ala., and Boll in Dallas, Texas,* but Chapman failed to detect it in Florida; besides northern Texas, the westernmost localities reported appear to be Ogle Co., Ill. (Allen) and Wisconsin, not rare (Hoy); in the northern part of the United States it rarely or never reaches the limit of the Alleghanian fauna and it is not reported west of the Mississippi River; the northernmost localities in which it appears to be found are these last and Michigan (Mus. Mich. Univ.), New Jersey (Merrill, Aaron), about New York City (Graef, Tepper, Davis), Newburgh (Edwards) and Albany, N. Y. (Hill).

In New England it is consequently a rare insect and confined to the southern portions. It has, however, occasionally occurred in abundance in New Haven and vicinity (Smith), and in Plantsville (Shepard), and New Britain, Conn. (Hulbert); "two or three are taken every season" near

*Mabille gives it from "Amérique méridionale!"

Springfield (Emery, Dimmock), Parker reports it from Mt. Holyoke, single specimens are taken at rare intervals in the vicinity of Boston, Mass. —Waltham, Winchester, Wollaston (Sanborn, Plympton, Thaxter, Scudder, Sprague). On only one occasion have I seen any considerable number in one day. C. P. Whitney has even taken three or four specimens at Milford, N. H.

Oviposition. An enclosed female laid eleven eggs for me, all, with one or two exceptions, on the under side of the leaves. These hatched, at end of June, in about a week. In West Virginia Mr. Edwards found them hatch in four days.

Food plants. Enclosed females laid freely both for Mr. Edwards and myself on *Desmodium* and were raised on that plant, in Mr. Edwards's case on *D. dillenii*. Abbot and Smith figure it on *Desmodium paniculatum*, a broad leaved form; but Abbot in his MS., besides beggar's lice (*Desmodium*), gives "indigo" (*Indigofera* or *Baptisia*?) and "the plant figured," which in this instance is *Ipomaea pandurata*, one of the *Convolvulaceae*. On one occasion I saw a female flitting about a plant of *Corydalis glauca*, one of the *Fumariaceae*, as if wishing to lay eggs there. Its food is therefore probably wider than the *Leguminosae*, though these are certainly its favorites, and among them *Desmodium* holds the first place.

Habits of the caterpillar. In constructing its home the caterpillar seems to select by preference a place where one leaf covers another and stitches them together for a most innocent looking nest, which disturbs the natural arrangement of the leaves to the least degree. It prefers at first an elevated place near the summit of *Desmodium*, but when it becomes more than half grown requires the larger leaves below. It repeatedly changes its home, quitting it the moment it becomes too strait and constructing another, often crawling some distance, as to a contiguous plant, to make a good selection. On deserting its old nest it partially destroys it by cutting most of the threads, apparently because this gives the nest the appearance of having been torn open and the occupant made away with. When at rest, at least when more than half grown, the larva lies with head and tail facing in the same direction, after the fashion of many other *Hesperidi*. According to Abbot, with its last moult, the yellow markings become pink.

Seasons and habits. It is single brooded in the north, and double brooded in the south, hibernating in both regions as a chrysalis. In the south, the earliest butterflies appear in Georgia about the middle of April and the second brood, after passing 13 days in the chrysalis (Abbot), before the middle of July. In New England the butterflies appear in the latter half of May, probably about the 20th, though rarely before the first of June about Boston, doubtless continue to emerge from the chrysalis until the middle of June, and fly until about the middle of July; but all July

specimens are invariably worn and battered. They deposit their eggs in the latter part of June when the butterflies are most abundant: mine were laid June 25 and 26; they hatch in a week and the caterpillar grows slowly in no more than time to reach chrysalis before the end of the season. In West Virginia, Edwards obtained eggs on June 4, which would seem to give still ample time there for a second brood of butterflies, though this is not certain; but about the middle of July the butterfly becomes very common in Nashville, Tenn., and this must represent the second brood.

Abbot says the butterfly frequents swamps, hummocks and oak woods. I have always found them in open spots in woods on rocky soil, flying about the blossoms of the butterfly weed, *Asclepias tuberosa*, and extracting their sweets in company with *Epargyreus tityrus* and *Atrytone zabulon*. They are also fond of the flowers of *Phlox*.

Desiderata. The whole history and distribution of the butterfly are but meagrely sketched above. We need to know more of the larval habits, especially at maturity, no proper description of the chrysalis has been published, and even the seasons are very inadequately known; the features accompanying the change from monogoneutism to digoneutism especially need investigation. We are not even certain of the mode in which the winter is passed. Nothing is known of the flight and postures of the imago and very little of its haunts and habits.

LIST OF ILLUSTRATIONS.—*ACHALARUS LYCIDAS*.

- | <i>General.</i> | <i>Chrysalis.</i> |
|--|---|
| Pl. 27, fig. 6. Distribution in North America. | Pl. 85, fig. 21. Chrysalis. |
| <i>Egg.</i> | <i>Imago.</i> |
| Pl. 66, fig. 15. Egg. | Pl. 9, fig. 11. Male, both surfaces, colored. |
| <i>Caterpillar.</i> | 35: 44. Male abdominal appendages. |
| Pl. 73, fig. 6. Caterpillar at birth. | 41: 5. Neurulation. |
| 76: 23. Mature caterpillar, dorsal view. | 47: 2. Scales of the male imago. |
| 80: 17, 18, 23, 24. Front views of head, | 57: 1. Side view of head and appendages |
| stages i, ii, iv and v. | enlarged, with details of leg structure. |

THORYBES SCUDDER.

Thorybes* Scudd., Syst. rev. Amer. butt., 50
(1872).
Eudamus pars Auctorum.

Goniloba pars Auctorum.
Aethilla pars Butler.

Type.—*Papilio bathyllus* Smith-Abb.

Now, midst her wanderings, on a hot noontide,
Psyche passed down a road, where, on each side
The yellow cornfields lay...
The lark sung over them, the butterfly
Flickered from ear to ear distractedly.

WILLIAM MORRIS.—*The Earthly Paradise*.

Imago (58: 2). Head large, profusely clothed with mingled curving scales and hairs of moderate and equal length, mostly arranged in transverse appressed rows; at the outer base of the antennae, a moderately long, thick, equal bunch of bristly hairs, slightly curved and inclined forward and outward; the whole of the front consider

* *Θορύβης*, to be a flusterer.

ably and equally surpassing the front of the eyes yet not very tumid and not falling off behind, but connected with the vertex by a common and slight tumosity and separated from it by a straight, scarcely impressed line joining the middle of the bases of the antennae; the front margin scarcely convex excepting toward the sides, very slightly and equally emarginate; margin of the sides well rounded off in front, behind reaching the outer edge of the antennal base and angulated; rather more than twice as broad as long; vertex rather larger than the front, scarcely tumid and yet elevated equally and very slightly above the level of the eyes, slightly hollowed, like the front, in the immediate vicinity of the eyes, its posterior border somewhat convex, a little bent in the middle, marked by a slightly impressed sulcation. Eyes large, full, nearly round, naked; antennae inserted in shallow pits, their posterior bases slightly in advance of the middle of the summit, their interior bases separated from each other by nearly twice the diameter of their basal joints; exclusive of the crook about one-third longer than the abdomen, the whole composed of 53 joints of which 30-31 form the club, which is scarcely more than half as long as the stalk and bent somewhat beyond the middle at about the 36-37th joints; the club increases very gradually and regularly in size up to where the curve commences and is about as broad as the length of one and one-half of the joints; it tapers nearly as gradually, the joints being also proportionately shorter and, excepting the conical apical joint, is as large at the tip as the stalk; the joints in the middle of the stalk are scarcely three times as long as broad. Palpi very short and very stout, somewhat longer than the eye, heavily clothed with long and erect scales, beyond which nearly the whole of the stout but minute apical joint projects, clothed only with recumbent scales; basal joint small, tumid, considerably prolonged at the tip on the inner side into a bulbous projection which seems to support the sides of the tongue; second joint tumid, ovate, scarcely more than twice as long as broad, more than twice as long as the basal joint, straight or nearly so, approaching a conical form on its apical third, the apical joint inserted near the middle of the tip but somewhat on its anterior face and so projecting forward, minute, slender, cylindrical, conical at tip, twice as long as broad and fully half as long as the breadth of the middle joint.

Prothoracic lobes small, strongly appressed, laminate; when viewed from the front suboval, broadly rounded interiorly, bluntly pointed exteriorly, more than twice as long as broad, nearly as long as the shorter diameter of the eye. Patagia large, closely resembling that of the preceding genus, somewhat shorter than the breadth of the head.

Fore wing (41:3) shaped almost precisely as in *Achalarus*. Costal margin thickened in its basal half; costal vein terminating shortly before the tip of the cell; first superior subcostal nervule arising opposite the second median nervure, just before the middle of the apical two-thirds of the cell; the subcostal nervures similar, excepting that the fourth is sinuous and strikes the apex of the wing, and they originate at subequal intervals, the widest space occurring between the second and third; the origin of the fourth superior and of the first inferior nervules very much as in *Achalarus*; first median nervule arising near the middle of the basal half of the wing; cross vein obsolete excepting at its extremities, running obliquely, subparallel to the extreme lower portion of the outer margin; internal nervure very short, running by an upward curve into the submedian; cell about six times as long as broad, and more than two-thirds as long as the wing.

Hind wings shaped much as in *Achalarus*, but more uniformly rounded; the outer margin entire, produced in the submedian region; the whole wing scarcely longer than broad; the hind margin is broadly angulated at the submedian nervure, more strongly in the male than in the female; and the internal margin is only roundly and gently bent at the tip of the internal nervure. Costal, precostal and subcostal nervures much as in *Achalarus*, but the costal and subcostal not completely consolidated at their point of parting, the subcostal forking at slightly more than one-third way to the margin of the wing; first submedian nervule originating as far before the subcostal forking as its second branch beyond it; the cross vein entirely obsolete, its

position indicated only by the slightest possible bend in the subcostal nervure, somewhat beyond its fork; other veins as in *Achalarus*, but the internal nervure slightly longer than there.

The scales enclosed in the costal fold of the male include flagellate chain-bristles with elongated links, obspatulate, slender androconia, and on the pavement below the costal vein peg-like, minute androconia.

Legs 2, 3, 1, tufted as in *Achalarus*; femora 2, 1, 3; tibiae 2, 3, 1; tarsi 3, 2, 1; fore and hind femora of equal length, the middle femora nearly half as long again. Fore tibiae three-fifths the length of fore femora, half as long as the middle tibiae, which are nearly as long as the middle femora; hind tibiae as long as hind femora. Leaf-like appendage of fore tibiae long and slender, originating in the middle of the outer two-thirds of the tibia, nearly six times as long as broad, considerably surpassing the tip of the joint, slightly arcuate, tapering delicately throughout its length, pointed at tip; middle and hind tibiae furnished at tip with a pair of long, slender spurs, the hind tibiae with a similar pair just beyond the middle. Tarsal joints 1, 2, 3, 5, 4, the apical scarcely longer than the penultimate joint; fore tarsi considerably shorter than the middle, two-thirds the length of the hind tarsi, as long as the middle femora; all with a triple row of delicate spines, the apical ones of each joint considerably longer than the others; basal joint as long as the rest together; second joint two-fifths as long as the basal joint. Claws small, very slender, tapering, bent at right angles in the middle; pad moderately large, roundish; paronychial apparently aborted.

Upper organ of male abdominal appendages small, not compressed, gently arched, the hooks much as in *Eudamus*; lateral arms forming a sheath similar to that of *Achalarus*, reaching about to the middle of the hooks. Clasps pretty large, broad, gently convex, at least twice as long as broad, nearly equal, with scarcely more mark of the upper lobe than a transverse, deep notch or incision near the extremity of the upper border, the apical parting of the clasp being full and upturned, so as to crowd upon the hinder extremity of the lobe.

Egg. Compact, subglobular, rather broader than high, the sides very full and well rounded, broadest just above the base, the base flat, rounded at the edges, the upper portion broadly rounded, the extreme summit flat; furnished with a moderate number of slight, straight, vertical ribs, extending from near the base to the rim of the summit, where, and next the edge of the summit itself, they are connected by three approximate, irregular sets of nearly as elevated cross ridges; below, the egg is traversed also by very frequent, delicate cross lines, at regular distances apart. Micropyle rosette small, consisting of five or six oval cells surrounding a central circle, and themselves surrounded by a single row or two of somewhat irregularly disposed, slightly larger, roundish oval cells, all bounded by very delicate lines.

Caterpillar at birth. Head suborbicular, higher than broad, smooth, the two lobes separated by a moderately deep incision above, half as broad again as the body when born. First thoracic segment entirely coraceous, the upper part, above the spiracles, denser. Rest of body cylindrical, uniform, terminal joint broadly rounded. Dermal appendages long, slender, erect, tapering hairs, scarcely knobbed at the tip, seated on warts arranged as follows: a supralateral series, scarcely in advance of the middle on the thoracic, anterior on the abdominal segments, the bristles directed a little inward; an infralateral series, central on the thoracic, postero-central on the abdominal segments, the bristles directed a little backward; a suprastigmatal series on the abdominal segments, centrally placed; all the above with one papilla to a segment in each row; and an infrastigmatal series, also one to a segment, and centrally placed on the thoracic segments, two to a segment on the abdominal segments, one either side of the middle, the hinder a little lower than the other. Hooklets of prolegs forming a continuous circle.

Mature caterpillar. Head subglobular, the front aspect showing an almost complete circle excepting for the slight indentation at the summit separating the two hemispheres; less than half as high again as deep, of nearly equal depth in the lower half, the front rapidly receding above to the comparatively shallow summit, posteriorly truncate; collar longer than usual, narrower than usual, being scarcely a third

the width of the head; inner frontal triangle reaching the centre of the head, fully half as high again as broad at the base; head rugulose; the lower portion of the face with striae converging as usual toward the mouth parts; the whole head covered with rather sparse and rather short, simple pile; ocelli as in *Epargyreus*, excepting that the arcuation of the anterior ocelli is more gentle and they are more inequidistant. Dorsal shield of the first thoracic segment conspicuous, equal, roundly truncate shortly above the spiracles; rest of body plump but elongate, largest at the third and fourth abdominal segments, tapering more gently in front than behind, but rapidly in front of the second thoracic segment; the last segment posteriorly narrowed, strongly rounded; abdominal segments divided into a broad anterior section, occupying rather less than one-third of the segment, and four posterior subequal sections; surface sprinkled rather sparsely with minute, cylindrical papillae scarcely smaller at tip than at base, considerably higher than broad, and furnished with short, apically expanded but otherwise tapering hyaline bristles, the apical expansion more than equalling the base of the bristle; there is a laterodorsal series of minute crateriform annuli situated in the middle of the anterior section on the abdominal segments, in the anterior half of the dorsal shield of the first thoracic segment and in the middle of the three or four subsections into which the thoracic segments are divided; an infralateral series of similar but exceedingly minute annuli in the same position; on the second thoracic segment the annuli of this series are larger than elsewhere and lie at the upper extremity of a large, broad, low, wart-like prominence, bearing in its centre a papilla with a long bristle; an infrastigmatal series on the abdominal segments situated a little in advance of the stigmata but on the first abdominal segment directly beneath it and removed from it only by the diameter of the spiracle; spiracles pretty large, prominent, crateriform, broad, oval; legs and prolegs as in *Epargyreus*.

Chrysalis. Prothorax scarcely more separate from the metathorax than from the head, with the latter forming a rectangular mass only slightly narrower than the mesothorax, the front roundly protuberant in the middle half, it and all other protuberant parts very sparsely pilose; mesothorax of nearly uniform width throughout, but slightly the widest at the basal wing tubercles, which are double, superior and inferior, but bluntly rounded and scarcely marked beyond the angulation of the body at this point; a distinct tubercle in the middle of the mandibular plates; prothoracic spiracle with a distinct, elevated and margined posterior lip, almost hemispherical, outwardly just within the lateral limits of the prothorax; mesothorax of equal length and breadth; beyond, the body scarcely enlarges to the third abdominal segment, beyond which again it narrows but with greater rapidity and tapers conically to the cremaster, interrupted only when the abdomen is extended by the protrusion of the movable segments; viewed laterally the mesothorax has an exceedingly low arcuation; the whole body is furnished with rather short, distant hairs arising from minute, scarcely perceptible papillae. Movable abdominal segments ridged much as in *Eudamus* but less prominently. Preanal button consisting of an extremely regular, transverse, high, C-shaped ridge open toward the cremaster, the back of the C perfectly straight, and preceded by some lumpy tubercles at the latero-ventral corners; ninth abdominal segment with a rough, transverse, dorsal ridge, falling off rapidly to the cremaster, which, as viewed from above, is triangular, apically rather broadly truncate and toward the base with a moderately deep, large, triangular depression; beneath sulcate as in the preceding genera; viewed laterally it is nearly straight with a slight arcuation and of nearly uniform size; only the extreme tip is armed with hooklets, which are unusually long and slender, but otherwise shaped much as in *Eudamus*.

Thorybes belongs to a group of purely American forms very numerous within the tropics; this genus, however, is best developed in the northern tropics and the adjoining temperate zone, and in the former region is perhaps limited to the high lands alone, though Bates brought home one species from Para. It extends north to the 50th degree of latitude on

either side of the continent and in the interior five degrees further. In the south it reaches at least as far as Guatemala, although apparently absent from the Antilles. Two species occur in New England, one abundant everywhere, the other found in the southern portions only and rare.

The butterflies are above the medium size for Hesperidae, with very broad, ample wings of simple form and of a dark brown color; the fore wings are flecked with small or very small, irregular, white spots, mostly scattered in a very irregular, transverse line across the middle of the wing. The hind wings are crossed beneath by two rather narrow, parallel, inconspicuous, darker bands.

They are single or double brooded, wintering in the chrysalis state. The butterflies frequent meadows and, being very strong bodied, fly with remarkable dash and celerity. They are exceedingly numerous in individuals and love the hottest sunshine, although they continue on the wing later in the day than most butterflies. In repose all the wings are equally elevated. The eggs, which hatch in a few days, are laid singly upon the under side of leaves and the caterpillars live sluggishly in nests made much after the fashion of those of the following genus. They feed on leguminous plants—principally on clover and *Lespedeza*.

The eggs are subglobular and furnished with a moderate number of slight vertical ribs. The caterpillars are stouter than in the previous genera, forming a passage to *Thanaos*, with a very strongly constricted collar and a large head, the body pale with a few indistinct, longitudinal bands. The chrysalids are slenderer than in the preceding genera, but rounded as there.

EXCURSUS LVI.—SOME SINGULAR THINGS ABOUT CATERPILLARS.

A pensive Ant, right trig and clean,
Came ae day whiddling o'er the green;
Where, to advance her pride, she saw
A Caterpillar moving slow.
"Good ev'n't ye, mistress Ant," said he;
"How's a' at hame? I'm blyth to s'ye."
The saucy Ant view'd him with scorn,
Nor wad civilities return;
But geeking up her head, quoth she,
"Poor animal! I pity thee:
Wha scarce can claim to be a creature,
But some experiment of Nature,
Whase silly shape displeas'd her eye,
And thus unfinish'd was flung bye,
For me, I'm made with better grace,
With active limbs, and lively face;
And cleverly can move with ease
Frae place to place where'er I please;
Can foot a minuet or jig,
And snoot like ony whirly-ig;
Which gars my jo aft grip my hand,
Till his heart pitty-pattys, and—
But laigh my qualities I bring,

To stand up clashing with a thing,
A creeping thing the like of thee,
Not worthy of a farewell t'ye."
The airy Ant syne turned awa,
And left him with a proud gaffa.
The Caterpillar was struck dumb,
And never answer'd her a mum:
The humble reptile fund some pain,
Thus to be banter'd with disdain.
But tent hest time the Ant came by,
The worm was grown a Butterfly;
Transparent were his wings and fair,
Which bare him flight'ring through the air.
Upon a flower he stapt his flight,
And thinking on his former slight,
Thus to the Ant himself address'd:
"Pray, Madam, will ye please to rest?
And notice what I now advise:
Infoliors ne'er too much despise,
For fortune may g'e sic a turn,
To raise aboon ye what ye scorn:
For instance, now I spread my wing
In air, while you're a creeping thing."

ALLAN RAMSAY.—*The Caterpillar and the Ant.*

SOME one has said that it is the unexpected that always happens. So, to one who may be tolerably familiar with the structure of caterpillars,

some new and unexpected feature often presents itself and will then appear in the same or in some modified form through a long series of different species. Or the arrangement or disposition of parts with which he is perfectly familiar may suddenly be found to follow certain laws which he can formulate but not explain, and which he had before overlooked.

One of the most fundamental facts in the structure of caterpillars, as of all arthropods, is the repetition of similar parts along the several rings of which the body is composed. But there are in caterpillars, at least, two disturbing elements which modify this law; one, considering that the metamorphoses of insects are conceded to be an acquired characteristic, is readily explained, and that is the difference between the structures found on the thoracic and the abdominal segments. Thus, on account of the development of the future wings, the spiracles of the second and third thoracic segments are omitted, and the legs found upon the thoracic and abdominal segments are very different in character, those of the abdominal segments being a temporary expedient for the long trailing abdomen, while those of the thoracic segments are more highly developed. But these exceptions, which have a direct relation to the future needs of the animal, cannot explain certain other features which show similar differences. In general terms, the entire surface structure of the upper part of the animal is practically identical on the thoracic and abdominal segments, but there are certain differences which appear, to which no explanation is readily given.

For instance: By the transverse creases which simulate the incisures between the segments, each segment is ordinarily divided into two or more transverse sections. Now these sections, at least when there are more than one or two, invariably differ upon the thoracic and abdominal segments, the abdominal segments having a system of their own, distinct from that of the thoracic. The first thoracic segment, indeed, is the subject of great specialization and differentiation, and often differs widely in its divisions, as also in the appendages it bears, from the other thoracic segments; but this is not true, or is true in an extremely limited sense, as regards the other thoracic segments, which to all practical purposes are identical in general appearance with the abdominal and would seem to have much the same office to fill. Yet, if we examine carefully the dermal appendages of these segments, we shall note some curious features distinguishing them from those of the abdominal segments. Thus, the spines, bristles, filaments, or other special developments of the skin, are ranged in most caterpillars of butterflies in longitudinal rows when they have any regular disposition whatever. There may be one or two or more upon each segment in a single row; all the spines of one row will be found at corresponding points of the different segments, either on the middle or back or front, as the case may be. Yet with scarcely an exception among the caterpillars of butterflies, those series which extend along the abdominal segments will either stop altogether at the thoracic

segments or slightly change their direction at this point, so that often we may readily distinguish the thoracic from the abdominal segments without looking at those parts which characterize them distinctively, such as the legs or spiracles. Thus, even in the mere disposition of the spines along a caterpillar's back, the future separation of the thorax and abdomen is foreshadowed. This is wholly independent of the larger amount of space upon the thoracic tract due to the absence of spiracles; for, when the spines are well developed on the first thoracic segment, which bears an unusually large spiracle, they are aligned with those of the other thoracic segments and not with those of the abdominal segments.

This, like the absence of spiracles from the second and third thoracic segments, might be explained on the theory that the transformations of the insects are an acquired characteristic, a development backward from the imago. But this will not explain another peculiarity which one observes in the general arrangement of the spines and other dermal appendages on the back of caterpillars, a feature which is extremely common, though perhaps not universal, with all vermiform creatures. I refer to what might be called the polar or antithetic arrangement of these appendages, which shows itself in a multitude of ways. As a general rule the hairs, spines, filaments, or what not, are highly developed upon the thoracic segments, sometimes increasingly so from the hindmost forward, the series culminating in lofty bristles or long appendages upon the first thoracic segment. When this occurs, it is an almost invariable rule that a similar but reversed arrangement and extension of the same class of appendages is found upon the terminal abdominal segments. Or, if, as is frequently the case, the second or third thoracic segment is independently enlarged or its armature specially magnified, a similar but generally lesser development will be found to occur on one of the preterminal, though not the terminal, abdominal segments. A case in point is easily seen in the caterpillars of the genus *Basilarchia*, where the second and third thoracic segments are mamillate and the second is crowned by a pair of stout, thorny tubercles. So, too, in a less degree, the seventh and eighth abdominal segments are slightly hunched and the corresponding tubercles at that point are noticeably enlarged, especially on the eighth segment.

Many other similar features might be pointed out even among the limited series of our own caterpillars, as in all the young *Papilioninae*, and this symmetrical polarity seems quite akin to that which we have pointed out in the markings of the wings of butterflies, where corresponding ocelli are found upon the wings in antithetic positions as related to the vein structure beneath. Another instance of this polarity is seen in many of the caterpillars of the *Satyrinae*, in all of which the terminal segment ends in a fork of greater or less dimensions, in some instances taking the form of a long, pointed spine on either side, directed backward. When this is

the case, and especially when it is most developed, the head also is crowned with a similar pair of pointed spines, and at rest the head is bent downward, so that these spines are thrown forward and the body ends at each extremity in a pair of long pointed spines. In this instance, at least, a purpose might be seen in such an armature, for it would appear as if the head bearing these long pointed spines would present a formidable appearance to some of its enemies, especially as it is able to present these organs at any point with great force and rapidity; if an enemy, alarmed at the front aspect, sought to assail the creature in the rear and were to find a similar pair of spines, it might well be conceived that he would presume that these also could be used with equal offensiveness. Possibly this will explain many other cases.

If we examine the arrangement of the spiracles upon the sides of the body, we shall find that the first thoracic and the last abdominal pair are invariably much larger than the others, which are equal among themselves. The explanation of this is easy. The respiratory tube of each has to feed a very much larger field, the head and second thoracic segments being fed by the tubes finding their outlet at the first thoracic segment, and several of the hinder abdominal segments of the body being equally dependent upon that of the eighth abdominal segment. The spiracle of the first thoracic segment is also situated on a higher level than the ordinary abdominal spiracle, and this is a consequence, in part at least, of the ordinarily smaller size of this segment; yet it is also true in those forms in which the first thoracic segment is greatly enlarged. But what is curious is that in certain groups, the *Lycaeninae*, in particular, and the *Hesperidae* to a less extent, the spiracle of the eighth abdominal segment is also situated at a considerably higher level than those of the other abdominal segments. This seems another instance of the polar arrangements of parts to which we have alluded, but the explanation here is less obvious, since it is a characteristic only of certain groups, and even here is not invariable; for in the caterpillar of *Feniseca*, one of the *Lycaeninae*, the eighth abdominal spiracle is quite on a level with those in advance of it, just as it is in the bulk of butterfly caterpillars. The only reason for this elevated position in these cases would seem to be the particular form of the termination of the body, for in all the *Lycaeninae*, excepting *Feniseca*, and in all the *Hesperidae* in which this occurs, we find a flattened subonisciform shape, one which, indeed, throws the spiracles of all the abdominal segments a little higher relatively to the base of the body than is common among caterpillars in general.

Besides the spines, filaments, bristles, etc., which form so noticeable and common a feature among butterfly caterpillars, there is another still more common and of a very similar nature; that is, the short hairs or pile with which the body is provided, always supported by little papillae and dis-

tributed with great regularity, in which a transverse is more often seen than a longitudinal direction, sometimes dispersed indiscriminately all over the body. When a transverse arrangement obtains, it is usually related closely to the sections into which the segments are divided. The use of this clothing for the body is tolerably clear, since this pile must prevent the too rapid evaporation of the heat from the surface of the body; for, although caterpillars would be classed among the cold-blooded animals, they nevertheless have an internal heat above that of the surrounding atmosphere, which originates from the activities of the organs and the respiratory function, and which they would lose more rapidly but for this investing pile.

But there are two other series of structures, always arranged in longitudinal rows, the use of which is wholly unknown. One of these is a universal characteristic of all caterpillars in their earliest stage, excepting probably the larger part of the highest family, and is common to the later stages of some of the lower families; and that is the special papilla-mounted bristles which are furnished with an expanded trumpet-mouthed tip and are the ducts leading from glands at their base which secrete a transparent fluid, which, after secretion, is borne in a little globule in the mouth of the trumpet, and sometimes kept in its place by a few microscopic bristles which surround its rim. That these have some protective function is highly probable, but what its nature may be or how it acts, is quite unknown. That they may be odoriferous seems highly improbable, for, though we can easily conceive that their insect enemies might perceive an odor from them, did such exist, which would be imperceptible to our senses (as we have the best reason for believing is the case with minute odoriferous organs of the perfect insect), yet we have not a particle of evidence to this effect, since in not a single instance have we been able to perceive any odor whatever from them. In the case of the organs of the mature forms, we conclude them to be odoriferous because in a few instances we can perceive an odor, and may fairly argue that entirely similar structures in others from which we can perceive no odor give off, nevertheless, some scent. Such evidence is absolutely wanting with regard to the present structures, and their use is therefore a subject for research. On experimenting, however, with some of the caterpillars of Pierinae which bear them when full grown, I have found the globule at the summit to be visibly increased when the creature was disturbed.

There is still another structure only recently made known, the purpose of which is obscure. These are the crateriform, chitinous annuli, which are ranged in longitudinal rows along the abdominal and sometimes the thoracic segments. They are found only in certain groups, but appear to be a universal characteristic of the earliest stage of the Lyncenidae, and have the appearance of spiracles, only they are ordinarily quite circular,

while spiracles are ordinarily oval, and they present no opening in the centre, but only, as far as I have been able to observe, a simple pit of more delicate structure than the chitinous annulus itself. They are found also in some Hesperidae in their earliest stage and sometimes also throughout life. But for the tenuous structure of the pit in the centre, they would have all the appearance of suppressed spines, and, indeed, the central pit seems sometimes to be wanting, and we have simply a shining lenticle, similar to those which are so common in the Papilioninae. But whether they should be looked upon as structures on their way to some use, or as effete structures, degenerated spines so to say, we have no facts at present to show, and an explanation of their purpose is still to be sought.

The discussion of these odd structures and curious arrangements of parts in caterpillars may already have been extended to sufficient length, but I should like to draw a moment's attention to two other special points in the structure of caterpillars which are still enigmas. One is the purpose or cause of the excessively constricted neck of caterpillars of the Hesperidae, a universal characteristic and one that is widely different from the frequent enlargement of this segment, as we find it in the Papilioninae, and to a much greater extent in the Lynceninae. Another is the curious swollen vesicle which hangs like a bag, a blunt, conical or transverse structure below the first thoracic segment in advance of the legs. Various suggestions have been made with regard to this. It is a very common occurrence, perhaps not universal, with caterpillars, but very much more highly developed in some than in others. In those in which it is most highly developed, we have found no habit or peculiarity which would explain its purpose. It is ordinarily covered with gritty tubercles of a special structure, but as far as I have been able to see, contains no openings whatever. Many other singular things about caterpillars needing explanation could be given, especially as regards their coloring, but these will suffice to show that there is yet a wide field open, even among our commonest forms.

THORYBES BATHYLLUS.—The southern cloudy-wing.

[White spotted tailed skipper (Maynard).]

- Popilio bathyllus* Smith-Abb., Lep. Ins. Geo., i: 43-44, pl. 22 (1797);—Abb., Draw. Ins. Geo. Br. Mus., xvi: 47, pl. 173 (ca. 1800).
Goniloba bathyllus Westw.-Hew., Gen. diurn. Lep., ii: 514, 534 (1852);—Lucas, Sagra Hist. nat. de Cuba, 638-639 (1857).
Hesperia bathyllus Morr., Syn. Lep. N. Amer., 106 (1862).
Eudamus bathyllus Herr.-Schaeff., Prodr. syst. Lep., iii: 67 (1868);—French. Rep. Ins. Ill., vii: 162 (1875); Butt. east. U. S., 369-370 (1886);—Mayn., Butt. N. Engl., 53, pl. 7, figs. 75, 75a (1886).
Ethilla bathyllus Butl., Entom. monthl. mag., vii: 57 (1870).
Thorybes bathyllus Scudd., Syst. rev. Am. butt., 50 (1872).
Popilio—Abb., Draw. Ins. Geo., Br. Mus., vi: 70, figs. 94-95 (ca. 1800).
 Figured also by Glover, Ill. N. A. Lep., pl. 29, fig. 11; pl. B, figs. 22, 23, ined.

Und trunken gleitet
Der Schmetterling vom schönen Blütenpfähle.
LINGG.—*Mittagszauber*.

Ho-day, what a sweep of vanity comes this way!
They dance!

SHAKESPEARE.—*Timon of Athens*.

Imago (17:18). Head covered above with blackish purple and dark brown scales and brownish olivaceous hairs, mingled with a few pale ones; tuft on outer side of the antennae black; beneath pale dirty yellow, extending as a narrow rim behind the eyes, nearly to the antennae and mingled above with brownish scales. Palpi pale silvery gray on the basal half, with a few dark fuliginous brown scales which gain the ascendancy on the apical half, especially in the middle, and grow darker toward the tip; blackish bristly hairs are found on the exterior half of the palpi and the apical joint resembles the parts about it. Antennae blackish purplish above, the whole stalk, excepting next the base, pretty heavily flecked with the silvery gray or nacreous tints which occupy the rest of the antennae, excepting the blackish apical halves of the joints on the anterior face; the anterior surface of the crook and the extremity of the club is naked and varies in color from fusco-castaneous to blackish.

Thorax above and beneath covered with dark brown hairs with occasional, intermingled, yellow and pale brown ones. Legs dark brown with purplish reflections, inconspicuously flecked above and externally with yellowish or pale scales, the inside of the tibiae and tarsi and the under edge of the inner surface of the femora clay brown, or excepting on the tarsi sometimes paler; the tibiae and joints of the tarsi are inconspicuously tipped with the same; the fringes of the femora are dark gray from an admixture of brown and yellow hairs; leaf-like appendages of fore tibiae glistening brownish yellow; spurs dusky, flecked with pale yellowish and tipped with dark reddish; spines dark reddish; claws the same at base, the apical half blackish; pad blackish brown.

Wings above very dark rich brown, usually with an olivaceous-purplish tinge, but on the apical third becoming gradually more or less considerably, though never greatly, flecked with dull yellowish scales which impart to it a grayish hue. *Fore wings* with a narrow, mesial series of five disconnected white or silvery spots, all but the middle one of which are found in a line drawn from the middle or scarcely beyond the middle of the costal margin to the extremity of the submedian nervure; the middle one occurs in the upper median interspace, is subquadrate and its interior border is generally on a line with the exterior borders of the others; the uppermost, above the subcostal nervure, is generally double and about as long as broad; that in the cell traverses it and forms a narrow, transverse stripe, or is more frequently hour-glass shaped or broken into two triangular patches, their apices scarcely separate, or is even wholly obsolete, although this is rare; that in the lower median interspace is a nearly equal, transversely oblique stripe, occasionally hour-glass shaped, generally fully twice as long as broad; the lowest is transverse, triangular, depending at right angles from the lowest median nervule beyond the middle of the outer half and extending across half the interspace; occasionally there is a minute, white spot resting on the middle of the upper median nervule; depending from the middle of the outer two-fifths of the costal margin, and almost at right angles to it is a scarcely arcuate, almost equal series of three or four closely connected white spots, the lowermost a little smaller than the others and inclined to be removed further toward the tip; the transverse series is about twice as long as broad, terminating at the next to the lowest subcostal nervule, next the lower edge of which still further toward the outer margin, a white or silvery dot is rarely seen. Outer margin indistinctly and narrowly edged with a black line. Fringe brownish yellow, somewhat infuscated above, paler below, the basal fourth dusky, but overlaid by pale hoary scales and the whole interrupted abruptly but not broadly with very dark or griseous brown at the nervure tips. *Hind wings* narrowly blackish next the outer margin; fringe nearly uniform, pale brownish

yellow, darker next the anal angle, rather broadly interrupted, but only on the basal third, by dark brown scales at the nervure tips.

Beneath of the same general color as above. *Fore wings* with the spots of the upper surface exactly repeated, the apex more or less extensively powdered with white or pale lilac scales, giving this portion of the wing a more or less decided hoary tinge or roseaceous bloom, which, when most conspicuous, brings into relief a short, slender, dusky, transverse striga, just beyond and below the outer costal spots, bent at right angles on the lowest subcostal nervule, and crossing the interspaces on either side of it; the inner border is pale or yellowish as far as the submedian nervure; outer margin narrowly and indistinctly marked with a black line; fringe much as above, but with rather more distinct markings. *Hind wings* traversed, above the submedian nervure, by two distant, equal, not very broad nor conspicuous, arcuate, and a little sinuate, dusky, transverse bands, generally darker at their edges than elsewhere, subparallel to each other and to the outer margin; the exterior edge of the inner band crosses the last divarication of the median and subcostal nervures; at the upper subcostal nervule it is broken and forked, and is represented in the interspace above by two subquadrate patches, the outer the larger, its interior edge crossing the middle of the interspace, the inner in the middle of the basal half of the same; the outer band crosses the wing midway between the inner band and the outer border; it is generally a little broader at its lower extremity—about half the width of the cell—and is more irregular in outline than the inner band, often changing its course in every interspace; the wing is besprinkled with white or pale lilac scales, usually infrequent, sometimes wanting within the outer band, generally present, however, along the inner border, and making the wing conspicuously hoary beyond the outer band, or at least in the outer half of the space beyond it, sometimes edging the exterior limit of the band in the lower half of the wing; outer margin delicately edged with a black line; fringe much as on the upper surface, but usually more infuscated below the median area.

Abdomen of the general color of the wings, flecked sparsely above, rather abundantly below, with pale, dull yellow scales, the apex of the scale at the extreme tip of body of the same tint. Upper organ of male appendages (35:38) having the hooks as long as the centrum, widely separated, but parallel and straight, the apex a little curved downward; lateral arms scarcely reaching the middle of the hooks; clasps fully two and one-half times longer than broad, the basal two-thirds equal, with a slight, broad, angular elevation at the middle of the upper edge; upper lobe marked only by an incision half across the blades, curving a little toward the base; beyond this the clasp tapers rapidly to a bluntly angulated extremity.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....				16.75	20.	23.5
antennae				9.75	11.75	12.
hind tibiae and tarsi....				7.	10.	10.75
fore tibiae and tarsi....				4.3	5.75	5.75

Described from 15 ♀.

Egg (66:9). As represented in the figure by Mrs. Peart, the egg is slightly broader than high, with about fourteen or fifteen slender, slight, vertical ribs and the cross lines so frequent as to break the surface into cells seven or eight times broader than high. Apparently it differs from that of *T. pylades* in being more oblate and with fuller sides.

Caterpillar. *Last stage* (76:32). Head (80:6) black, minutely scabrous, covered with a dense pile of golden brown or tawny hairs with a few intermingled black ones, the median suture rather deeply impressed above. Ocelli, jaws and antennae all piceous, as well as the neck.

Body dull mahogany brown tinged with luteo-olivaceous, profusely sprinkled with dirty, pallid wartlets, each giving rise to a very short, scarcely tapering, minutely clubbed hair, generally luteous, often black or black tipped, the black ones most abun-

dant in the posterior part of the body. There is a very faint and narrow, dusky, dorsal line, and a faint infralateral line scarcely lighter than the ground. Dorsal shield of first thoracic segment dull black, the softer integument in front and behind it pallid, with no sign of any brighter tint. Spiracles black. Legs black. Prolegs color of body. Length of body, 23 mm.; breadth of same, 4.5 mm.; breadth of head, 4.5 mm.

It differs from *T. pylades* in its generally darker color, in the color of the soft integument of the first thoracic segment, and appears also to be more scabrous.

Chrysalis (85:24). Dull greenish brown, the eyes and appendages with the posterior edges of the abdominal segments, the basal wing tubercles and the veins of the wings marked with fuscous brown; a few dots of the same along the posterior margin of the wing-cases. It is stouter bodied than *T. pylades*. Length, 23 mm.; height, 7.5 mm. After a colored drawing by Abbot.

Distribution (27:7). This butterfly is a member of the Carolinian fauna, where it seems to be an abundant species everywhere on the seaboard as far west as Texas (Belfrage, Aaron), beyond which I have seen specimens from Mazatlan (H. Edwards) and Costa Rica. It does not appear to have been taken in Florida farther south than the St. John's River, and it was not found by Grote at Demopolis, Ala., though mentioned by Gosse from that state. In the Mississippi valley it extends to northern Illinois (Worthington), Ogle Co. (Allen), Wisconsin abundant (Hoy), Ames, Io. (Osborn), eastern Kansas (Snow) and Fort Niobrara, Neb. (Carpenter), as well as west to New Mexico (Snow). Along the Atlantic coast it passes a considerable distance into the Alleghanian fauna, although nowhere common, having been found in West Virginia (Edwards), Maryland (Wiedemeyer), New Jersey (Andrews) and New York (Lintner).

In New England it has only been taken in the Connecticut valley, where it was first obtained at Springfield (Emery) afterwards at Sunderland and South Hadley (Sprague), Mt. Tom (Morrison) and Granby, Mass. (Scudder), and in New Britain, Conn. (Hulbert).

Food plant. Smith and Abbot figure this species on *Rhynchosia tomentosa* Torr. and Gray, and Abbot says it feeds on wild bean. Dr. Chapman has found it on other herbaceous Leguminosae, as *Tephrosia ambigua* Chapm., *Centrosema virginianum* Benth., and ? *Lespedeza hirta* Ell. Doubtless its habits are nearly identical with those of the following species.

Life history. Data for establishing a history of the species are very meagre and mostly due to Abbot. Apparently it is at least double brooded and passes the winter in a chrysalis state. The earliest brood of butterflies appears in April (April 18, ♀, S. Car., Atkinson); caterpillars from their eggs become fully developed between the middle of June and the end of July, and after passing about eleven days in the chrysalis, appear again on the wing. Abbot reared the butterfly on June 24th, July 2nd, and August 5th. Captures that I have seen were in August.

In the north the data are very imperfect; all the specimens I have seen

or heard of were taken in the first half of July, excepting that Mr. Emery took one in June. Apparently there is only a single brood, for a caterpillar, evidently from a July egg, became full grown very late in the season, and not having changed to chrysalis by the middle of October, was then placed in the cold storage house, but did not survive the winter, making it more apparent that the winter is passed in chrysalis.

Desiderata. So little is definitely known concerning the distribution of this butterfly, away from the southern Atlantic states, and of the details of its history, while all else is wholly unknown, that every fact is of importance. Care, however, should be taken that the insect is not confounded with its congener.

LIST OF ILLUSTRATIONS.—*THORYBES BATHYLLUS*.

- | | | |
|--|---------------------------------|------------------------------------|
| <i>General.</i> | | <i>Chrysalis.</i> |
| Pl. 27, fig. 7. Distribution in North America. | Pl. 55, fig. 24. Chrysalis. | |
| <i>Egg.</i> | | <i>Imago.</i> |
| Pl. 66, fig. 9. Colored. | Pl. 17, fig. 18. Both surfaces. | |
| <i>Caterpillar.</i> | | 35: 38. Male abdominal appendages. |
| Pl. 76, fig. 32. Mature caterpillar. | | |
| 80: 6. Front view of head, in stage v. | | |

THORYBES PYLADES.—The northern cloudy-wing.

[Dark brown tailed skipper (Maynard).]

Eudamus pylades Scudd., Proc. Bost. soc. nat. hist., xlii: 207 (1870);—Fern., Butt. Me., 106, fig. 35 (1884);—French, Butt. east. U. S. 368-369, fig. 88 (1886);—Mayn., Butt. N. Engl. 53-54, pl. 7, figs. 76, 76a (1886).
Ethilla pylades Kirb., Syn. cat. Lep., 573 (1871).
Thorybes pylades Scudd., Syst. rev. Am. butt., 50 (1872); Butt., 303, figs. 1, 188 (1881).
Hesperia bathyllus Harr., Hitchc. Rep., 590 (1883).

Eudamus bathyllus Harr., Ins. Inj. Veg. 3d ed., 312, fig. 135 (1862);—H. Edw., Stand. nat. hist., II: 475, fig. 604 (1884).
Eudamus bathyllus var. *pylades* Streck., Catal. Amer. Macrolep., 162-163 (1878).
Hesperia sp. Harr., ent. corr., 2:1 (1869).

Figured also by Glover, Ill. N. A. Lep., pl. 29, fig. 10, lued.
 (Not *Papilio bathyllus* Sm.-Abb.)

Insect lover of the sun,
 Joy of thy dominion!
 Sallor of the atmosphere;
 Swimmer through the waves of air;
 Voyager of light and noon;
 Epicurean of June;
 . . .
 Aught unsavory or unclean
 Hath my insect never seen;
 But violets and bilberry bells,
 Maple-sap and daffodils,

Clover, catchfly, adder's-tongue
 And brier-roses, dwelt among;

Seeing only what is fair,
 Sipping only what is sweet,
 Thou dost mock at fate and care,
 Leave the chaff, and take the wheat.

EMERSON.—*The Humble-Bee.*

Imago (9: 5; 13: 15). Head covered above with dark brown, mingled with rather pale yellowish brown scales and hairs, a slender rim behind the middle of the eye generally palest, the tuft on either side of the antennae blackish; palpi of mingled dark and pale fuliginous brown scales very sparsely flecked with pale scales and sprinkled, especially exteriorly, with black bristly scales; apical joint dark brown tipped with a few pale scales; interiorly the palpi are dust colored; antennae blackish brown above with a maroon tinge, the whole stalk, excepting next the base, flecked heavily with the silvery or dust colored gray which covers the rest of the antennae; the anterior surface of the crook and the extremity of the club are naked and dull castaneous.

Thorax covered above and beneath with dark brown hairs, occasionally flecked, especially on the patagia, sparsely and inconspicuously, with delicate yellow hairs; legs blackish purple, the femora and tibiae sparsely flecked above and exteriorly with pale yellowish and fringed with long hairs varying from brownish yellow to blackish purple with occasional intermingled yellow ones; inner side of the tarsi and apex of the tibiae and all the tarsal joints clay-brown; leaf-like appendage of fore tibiae glistening brownish yellow; spurs pale brown mottled with dusky and tipped with reddish; spines reddish luteous; claws the same, but deeper toward tip; pad blackish.

Wings above rich, dark, olivaceous brown, occasionally inclining to purplish, the outer half of the fore wing and occasionally parts of the basal half, generally flecked very sparingly but pretty uniformly, away from the nervules, with pale or greenish yellow scales, besides which the apical third of both wings have often a ruddy or dull olivaceous, or more frequently, a clay brown hue, which mingled with the scattered pale scales often gives a hoary tint to the apical portion of the fore wing, more characteristic of northern than of southern individuals; in the latter of which both flecking and gray tint are almost wholly absent. *Fore wings*: the white, generally rather dull white, spots found on the upper surface are very variable in their apparition; for while when fully developed they resemble in miniature those of bathyllus, several of them are usually absent wholly or partially, and the only ones which are pretty uniformly present are three sets: first, a small quadrate spot usually vaguely double between the costal border and the subcostal nervure in the middle of the wing, generally followed just below the subcostal by a very small triangular spot or dot half as large as itself; second, scarcely more than midway from this series to the apex a similar series of two or three, occasionally four, minute, square or squarish spots depending from the costal margin and bent at a little more than a right angle from its central portion; and third, a scarcely larger, usually triangular spot, seated upon and just before the middle of the middle median nervule; not infrequently however, this spot is larger and then it spans the interspace as a transverse dash and is accompanied by two smaller spots, usually a little smaller than itself, one just above and scarcely beyond the middle of the lower median nervule, the other, more persistent than the first, just below the middle of the outer half of the same nervule; this latter spot, though nearly always present, seldom increases in magnitude with the greater development of the other markings; the former, however, is occasionally accompanied by its reverse upon the upper half of the interspace and on rare occasions they unite to form an hour-glass shaped spot; the cellular spot is then usually accompanied, in the lower half of the cell by its partner, but almost never unites with it in individuals where the markings are unusually developed, a minute spot inserted on the middle of the upper median nervule; thus all the white markings of its congener may be represented, but as usually minute, occasionally small, disconnected spots, those below the subcostal nervure usually reduced to a minimum and some of them generally obsolete; veins sometimes darker than the ground color of the wing; outer border with a scarcely perceptible darker edging. *Fringe* gray brown, varying in shade, but on the basal third marked with one or two dark lines parallel to the border and beyond interrupted not very broadly at the nervure tips with blackish brown, which often expands a little toward the tip of the fringe. *Hind wings* with the gray tint of the outer half of some individuals deepening into a very broad but indistinct belt separated from the outer margin only by a narrow edging of blackish brown. Fringe in general much as in the fore wings, but often a little paler, more closely resembling the lower portion of the fore wings.

Beneath with the same ground color as above, but more or less flecked with paler scales. *Fore wings* with the outer half of the wing gradually and slightly shading into a dark, yellowish brown, at least in northern specimens, and with the vitreous markings of the upper surface exactly repeated beneath; beyond these spots, above the submedian nervure, the outer margin, especially in the ♀, is suffused to a greater or less extent, with a hoary tint, deepening outwardly, or sometimes confined to the immediate border, produced by a more or less profuse flecking of whitish, or very pale lilac scales, which, when most abundant, show traces of a bent and often broken streak of

the ground color on either side of the lowest subcostal nervule, commencing at the outside of the lower extremity of the subapical spots; edge of outer border narrowly marked with a dusky or blackish line; fringe much as above, but with the larger markings intensified, and sometimes with the extreme base affected by the hoary suffusion of the neighboring parts. *Hind wings* mostly of the tint of the outer half of the fore wings, crossed by two distant, not very broad, equal, often inconspicuous, tremulous bands, subparallel to each other, and the outer border a little darker than the ground color of the wings, but with all, excepting the edges, flecked with whitish scales or paler than the ground color of the wing; the inner band runs from the middle of the basal four-fifths of the submedian nervure to the divarication of the subcostal; it crosses only the costo-subcostal interspace by two distant, parallel bars, at equal distances on either side of what would be the continuation of the band, and entirely separate from it; the outer band lies about midway between the inner one and the outer border, is more tremulous in its course, its edges being sometimes almost zigzag; beyond this, the whole wing is always to at least a slight degree paler, and is often very considerably hoary, forming a belt which has its influence on the coloration of the upper surface of the wing; this hoary, pretty uniform flecking is similar to that of the outer border of the fore wing, and like that is more profuse and common in the ♀ than in the ♂, and in northern than in southern specimens; sometimes when the hoariness is comparatively slight, it is also confined to the outer half of this belt, and is then sometimes vague, bordered by a dusky, arcuate margin, which runs from the tip of the costal to the tip of the lowest median nervule; hoary scales are sometimes found scattered sparsely all over the wing; the outer margin is narrowly edged with a blackish line, which, as well as the extreme base of the fringe, is sometimes obscured by the hoary fleckings; fringe a little paler than above, bringing the darker markings into a more distinct relief, but otherwise similar.

Abdomen blackish brown, above sparsely flecked, especially toward the base of the joints, with yellowish scales; beneath, similar, but with more abundant flecking; tips of the scales at the very apex of the body faint, dull, olivaceous buff. Upper organ of male appendages (35:35) with the hooks as large as the centrum, rather widely separated, parallel and straight, the tip slightly uncinate beneath; lateral arms reaching beyond the middle of the apical half of the hooks; clasps more than twice as long as broad, the basal half equal, the middle of the upper edge with a slight, angular projection, the upper lobe marked by an oblique notch directed backward, one-fourth the depth of the width of the clasp at this point; beyond this the clasp is but one-half its original breadth, rounded at the tip, but above inconspicuously bicuspid.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	16.	18.	20.	18.	19.5	21.
antennae.....	9.6	11.2	11.6	9.6	11.	11.5
hind tibiae and tarsi..	7.75	9.	10.25	8.25	9.5	9.75
fore tibiae and tarsi..	4.45	5.5	6.5	4.75	5.3	5.5

Described from 93 ♂, 43 ♀.

Accessory sexual peculiarities. The costal fold of the fore wing of the male encloses many chain-bristles, with apical flagellum and composed generally of about half a dozen links, each about .058 mm. in length (48:3b); a great number of minute, peg-shaped bristles (48:3c), a little and very broadly constricted mesially, of varying lengths, but rarely as long as one of the links of the chain-bristle; and many slender, lanceolate, but apically rounded blades (48:3a), nearly or quite as long as the chain-bristles, apparently with a granular structure, but with the granulations elongate and longitudinal, giving the appearance of weakly interrupted, longitudinal canals.

Malformation. In one specimen before me there is a malformation in the antenna, an additional wedge-shaped, minute joint being forced in between two others at the very base of the club on the inferior surface; it is not apparent above.

Egg (66:7). Fifteen vertical ribs, rather delicate, sharply defined, scarcely reach-

ing the base of adhesion, .17 mm. apart, the space between gently hollowed and broken into narrow, transverse cells, by numerous cross lines, not clearly defined and but slightly raised, averaging .021 mm. in distance apart. Micropyle rosette (69:5) .085 mm. in diameter, central circle .0068 mm. in diameter, oval cells bordering it .017 mm. long, by .013 mm. broad. Color exceedingly pale green, almost white. Height, .69 mm.; width, .86 mm.

Caterpillar. *First stage* (73:5). Head (80:25) shining piceous, mouth parts black. First thoracic segment dark castaneous, with a black, dorsal shield reaching close to the spiracles on either side. Rest of body whitish, becoming greenish after feeding. Prolegs and legs pale, the claws of latter dusky, and the extremity of last joint, as well as the whole of first pair of legs infuscated. Hairs (86:45) about half as long as the segments (on hinder segments longer), dusky, those of the supralateral row inclined a little inward, those of the infralateral row a little backward. Length, 2.25 mm.; breadth, .4 mm.; of head, .65 mm.

The above describes the caterpillar just after hatching; the following description was taken at the maturity of this stage.

Head piceous, almost smooth, with a few scattered fine hairs. First thoracic segment reddish brown, with piceous dorsal shield. Rest of body dark green, with a faint lateral, yellowish green line, made up of a little more regularly in the otherwise somewhat promiscuous but regularly transverse series of crowded, yellowish green dots, not elevated above the surface, and each generally containing a central dusky dot, but not giving rise to any hair. [These are the minute warts of next stage. At the same time the long hairs of first stage still remain just as before.] Length, 4.25 mm.

Second stage. Head (80:26) black, delicately rugose, covered profusely with fine, short, golden hairs; first thoracic segment constricted, corneous, reddish black, naked, the shield piceous; rest of body rather dark green, with a fine, lateral, yellowish green line, and a similar but inconspicuous stigmatal line. Body studded with yellowish white and greenish white, minute warts, each giving rise to an exceedingly fine and very short, colorless, clubbed hair; the warts on under surface are wholly white. Legs (excepting first pair, which are wholly black), and prolegs wholly green; spiracles a minute testaceous ring; skin rather coarsely punctate. Length, 7 mm.; breadth of head, 1.2 mm.; of middle of body at rest, 1.4 mm.

Third stage. Head (80:27) black, delicately scabrous, covered with white pile, so as to give it a slightly hoary look. Body much slenderer throughout than the head; rather dull green, the terminal segment with a dull purplish tinge, and edged with pallid; whole body studded with minute, pale yellowish warts, those on thoracic segments, on the lower part of the sides and on the ventral surface almost pallid, each giving rise to an exceedingly delicate, short, white or pellucid hair; a faint, very slender, bluish dorsal line, and a slender, yellow lateral line; shield of first thoracic segment piceous, the rest of segment dull red. Length, 10 mm.; breadth of head, 2 mm.; of body, 1.5 mm.

Fourth stage. Head (80:28) brownish piceous, densely, deeply and yet delicately scabrous, profusely covered with a delicate gray pile; mandibles dark, shining castaneous; antennae piceous, bristle gray; first thoracic segment much contracted, dark vinous, with piceous smooth collar. Body rich clover green, the many incisures, a narrow lateral line, and the multitudinous wartlets yellow, the latter becoming pale on the thoracic segments and lower part of the sides, and from each of them a fine, short, clubbed, pellucid hair; dotted also somewhat abundantly, and on the last four segments abundantly with exceedingly minute black dots, collected more or less into irregular congeries; substigmatal fold pallid; last segment somewhat infuscated. Spiracles: castaneous; front pair of legs piceous, the others and prolegs green, the former with infuscated claws. Length of body, 18 mm.; breadth, 3.5 mm.; breadth of head, 3 mm.

Last stage. (76:25, 29). Head (80:29) generally pitchy black, sometimes varying to dark amber, densely covered with short whitish or hoary hairs which give it a fuzzy appearance, mounted on minute papillae, arranged to some extent in longitudinal rows;

mouth parts and ocelli black; the first joint of antennae pale, the others dark red, the bristle very long and hyaline. First thoracic segment black, below on the sides reddish, in front edged with red or orange merging into the black, covered, as is the rest of the body, with small, short, rather stout bristles. Body behind this rather dark green with three stripes: a narrow, dark brownish green, interrupted, dorsal stripe, a similar lateral stripe of a dull salmon or flesh color, and along the basal fold an infrastigmatal band similar to the last but paler and indistinct anteriorly; between the two lower stripes the body is profusely spotted with more or less raised papillae of a pale salmon color, the larger and higher distinct, the others less so, each bearing a hair similar to those on the head; marked also with a good many clustered, raised, black points between the wartlets, very abundant on the terminal segments; on the dorsal portion of the body the colors and marking are similar, but the salmon colored warts are more distinctly and highly colored, infringe more upon the dark green (which itself is hardly so dark) and are surmounted, as sometimes below, with a white or pellucid centre from which arises a white or pale brown bristle; on the terminal segments these bristles are nearly all dark brown and the black points are rather less profuse. Raised border of the spiracles black, the inner edge pale brown, outside a little paler. Basal joint of the first thoracic legs pale or colorless, the rest black edged, especially interiorly, with pale; claw blackish; other thoracic legs pale dirty yellowish; the last joint a little fuscous; claw blackish. Prolegs pale brownish yellow with an olivaceous tinge like the under side of the body; claws castaneous. Length, 28 mm.; breadth, 5 mm.; breadth of head, 4.1 mm.

Chrysalis (85: 28). Colors almost entirely black and fusco-luteous or olivaceous-livid. Head black, considerably mottled above with pale reddish luteous, with numerous short, curving, vinous hairs, clustered on the black spots, especially on the eyes, the mandibles and the extreme front; tongue at base luteous, edged broadly with black, just beyond black, transversely ridged with luteous, apical half fuscous; antennae blackish fuscous, transversely marked with luteous. Prothorax like the head; prothoracic stigmata velvety black. Thorax above luteous marked with blackish dots and curving streaks formed of collected dots, each giving rise to a lustrous, pale, vinous hair, the streaks more abundant along the sides of the hinder edge of the mesonotum and just behind the middle of the same portion; wings fusco-luteous, marked with frequent, slender, transverse, irregular streaks of blackish fuscous, mainly following the veins. Legs like the antennae. Abdomen sparsely haired; four basal joints pale, bespecked with black, the specks on the middle and posterior half mingled into transverse, partially associated patches; the concealable parts of the following segments are pale, unspecked; the other parts black, above dotted in a transverse row with luteous. Base of cremaster black above; the rest very dark mahogany; hooks castaneous. Spiracles reddish luteous in the centre edged with a rim of black. Length (including cremaster), 19.5 mm.; height at first abdominal segment, 6 mm.; breadth at third abdominal segment, 6.25 mm.; length of cremaster, 1.75 mm.

Distribution (27: 8). This butterfly has a very wide distribution throughout the entire United States, though it is not found in the Rocky Mountain region, nor has it been registered within our territory upon the Pacific coast north of central California. In the east it is apparently most abundant in the Alleghanian fauna east of the Alleghanies, but it extends northward far beyond its limits, having been found from Quebec, where it is numerous (Bowles), to Montreal "common" (Caulfield, Saunders), Ottawa (Billings, Fletcher), the Adirondacks of New York (Hill), London, Ont., "occasional" (Saunders), and southern Michigan "not common" (Harrington). Further west it has been rarely found, single specimens only being recorded from Iowa (Parker) and Illinois (Allen).

but it has been found much farther north, as in Wisconsin "common" (Hoy), Nepigon rare (Fletcher, Scudder), Fort Ellis, Manitoba (Geddes), Dufferin (Dawson), Heart River Crossing, Dak. (Allen), and other localities in Dakota (Edwards), and even at the mouth of the Saskatchewan River, Lake Winnipeg (Scudder). As regards its western extension the latter points in Dakota and on the Saskatchewan would perhaps mark its limits in the north were it not that it is found in Vancouver Island (British Museum, Fletcher). South of Vancouver Island it has not been noted until central California is reached, where it has been found at Gilroy (Behrens) and other localities (H. Edwards, de l'Orza), at Truckee, Sierra Nevada (McGlashan) and further south at San Diego (W. H. Edwards). It appears to be wanting in all the great Rocky Mountain region excepting along its southern margin where it has been brought from Mount Trumbull and Beaver Mountain in Utah (Palmer) and from New Mexico (Snow). But it is not again recorded in passing eastward until we reach Texas, where it is found at Dallas (Boll), and eastern Kansas (Snow). Notwithstanding that it is represented in the south by a commoner species, it is known along our border quite as far as it, reaching southern Texas (Aaron), though no specimens have been seen from Mexico, where the southern species occurs. It has been brought from Florida, from points further south than any recorded for *T. bathyllus*, having been found in Apalachicola (Chapman), and brought from St. John's River, St. Augustine and even Indian River by Dr. Palmer, and from there northward it is found along the whole Atlantic coast.

It has been found everywhere in New England in abundance from Nantucket and Connecticut in the south to the White Mountains and Maine in the north, in elevated stations as well as on the plains, but though very common in Maine according to Fernald and Miss Wadsworth, it has not yet been reported to the eastward in New Brunswick or Nova Scotia.

Oviposition. The eggs are laid on the under side of leaves; in the case of clover leaves, usually near the middle, a single egg to a stalk. They hatch in from five to ten days or perhaps longer in the latter part of June, the shortest period I have known being about four hours less than five days, the longest possibly twelve days, perhaps not more than eleven from an uncertainty of the exact day of laying. The ordinary time is about six days. Nothing would seem more hopeless than a hunt in a clover field for eggs of this butterfly, but in the proper season they may be found with the greatest ease after a little practice.

Food plant. The caterpillar probably feeds on almost any of the Leguminosae, but its common food appears to be *Trifolium* and *Lespedeza*. The common red and white clovers, *T. pratense* and *T. repens*, seem to be most sought. I have taken the caterpillar (as have others) on *Lespedeza capitata* and *L. hirta*, and Edwards obtained eggs from a female enclosed

on *Desmodium dillenii* and raised the caterpillar on it. I have also had eggs laid on grass blades beside clover.

Habits of the caterpillar. On emerging from the egg the larva usually devours only the upper half of the shell, then travels to another leaf and prepares a nest; it first bites two narrow, parallel, generally somewhat arcuate slits about 6 mm. apart, as many deep and as wide as its body, near the middle of one side of the leaf; the piece thus partially detached is then bent over and attached by silken cords to the upper surface and the caterpillar crawls within, secure from observation and the sun's rays; similarly constructed retreats answer its purpose as long as the leaf is large enough for the growing bodies, but afterwards they are apparently constructed like those of the mature *E. tityrus*. It is as cleanly in habits as the latter species, always retreating a few steps to the edge of its abode and elevating the terminal segment slightly to snap away its ejectionments. When placed upon fresh leaves it never ventures a step without lining the leaf with silk, moving its head from one side to the other as if it were searching for something between its front legs; while at its meals it retreats slowly, eating with its head close to its hinder extremity and devouring the leaves close down to the midrib; both when eating and when moving about, the head has always a tremulous motion.

Pupation. Cocoons constructed in captivity were made by fastening together clover leaves by a few strong, silken threads, so as to form a cell, scarcely longer than the chrysalis, but several times its size; the chrysalis was entirely concealed from view by the leaves, and the threads supporting the cremaster were pretty closely appressed to the end of the cell; these threads cross each other like an X, each thread being 8.5 mm. long and crossing the other in the middle, into which the crochets of the cremaster are plunged; after forming the Y-shaped thread, upon which the body is to recline, the caterpillar passes it beneath its body at the suture between the first and second abdominal segments; afterwards, just before the change of skin, it will be found between the second and third thoracic segments; the stem of the Y is 4.25 mm. long, or just as long as either arm of the X, and the forks each 6.5 mm. long; the chrysalid reclines on its ventral surface. In other cases, however, the threads at the hinder extremity also formed a Y like that of the front but with stem and limbs of similar length.

Life history. It is double brooded in the north passing the winter in the chrysalis state. It first appears as a butterfly toward the end of May, rarely earlier than the 24th* and usually not until the 27th or later. It becomes abundant in about five or six days, but the male is always so much more abundant than the female, that even toward the middle of June, when the latter is laying eggs in large numbers it is outnumbered

*I have taken females at this date.

three to one by the other sex; bad weather in the latter part of June will diminish the number of this insect seventy-five per cent in a few days, but a few always linger on until at least the middle of July and in elevated districts until the end of July. The eggs are mostly laid in the latter half of June, hatch in about six days, the caterpillars may be found half grown before the middle of July and fully grown from the 20th of the month until the early part of September; the insect remains in the chrysalis state about twenty days and the second brood of butterflies, which is much less abundant than the first (probably because many chrysalids continue until the next spring), appears in August, perhaps sometimes as early as the beginning, but usually not before the middle of the month, continuing upon the wing until past the middle of September; whether the progeny of this brood reaches the chrysalis stage before winter approaches has never yet been determined; if not it probably perishes.

In the south, the only data at hand, from the notes of Dr. Palmer, show that in central Florida the butterfly appears in the latter part of March and begins to grow scarce by the middle of April, so that a larger number of broods is to be looked for there.

Habits and behavior of the butterfly. Open fields and meadows are the favorite resorts of this butterfly, where it may be found passing from one flower to another, frequently alighting upon the heads of clover. Mr. Lintner has even found it resting on excrement in the road; open lanes or sunny grassy plots in woods are also frequented by it, and here it may be more readily captured. Its flight is difficult to follow, the butterfly is so quick in its movements and so vague in direction; it is never leisurely, and generally flies about two or three feet from the ground, not far above the tops of the herbage. It is infinitely more vigorous and rapid than the species of *Thanaos*, darting about in a frantic manner when alarmed and is often so fleet and irregular in its natural movements as scarcely to be followed in the lessening light of the declining day—to which it is the last of our butterflies to succumb. It is very pugilistic. I once saw one attack an *E. tityrus* which had invaded its domain, and drive off the intruder to a great distance by a vigorous onslaught, following its victim with unerring flight in all its twists and turns and keeping never more than a foot away, both speeding with amazing swiftness; by and by *pylades* came back to his haunt, but I waited in vain for *tityrus*.

While laying her eggs, the female flies much more slowly, moving in and out among the herbage at less than a foot from the ground, stopping very frequently, as if intending to alight, poising her heavy body with rapid fluttering of the wings and apparently touching the plants with her feet to feel their character; finding a clover leaf suited to her inclinations, she alights on the under surface with her head just at the edge and remaining on the leaf about three seconds, deposits a single egg somewhere near

the centre; she seems to select clover leaves having an independent stalk, standing rather high and to prefer those which are either in a thick clump or are sheltered to some degree by shrubbery or rocks. She always flies to some distance before depositing another egg, and such as are found on leaves in the near vicinity must always have been laid by different individuals or by the same on subsequent visits to the spot.

When alighted on a stalk or flower, the wings of this butterfly, the surface of which is a little arched, are held either at an angle of about 40° apart, the tips of the fore wings separated by a distance of about 15mm. and the costal border of the hind wing reaching the lower median nervure of the fore wing; or, more widely, at an angle varying from 80° to 110°; the antennae are deflected about 30° with the body and diverge at right angles. When resting on the ground, the wings are a very little elevated; the body is raised a little in front and the antennae are extended in the plane of the body, diverging at an angle of about 95°; they are straight, the club curving downward. When at rest in the shade, the antennae are extended laterally almost in a common line, but are bent a very little forward, kept often in a slight forward and backward motion; viewed from above, the apical half has a broad, slight curve, opening backward and including the club; viewed laterally they are straight, the club directed downward and outward and the whole antenna raised above the body at an angle of about 25°. When enclosed in a dark place, the antennae always diverge at an angle of 140°. When walking, the antennae are brought forward at about right angles, and viewed from above are not quite straight, but a little curved on the basal half, the convexity outward; they are on a plane with the body, the club curved downward and a little outward.

Some experiments. Handling a living chrysalis of this butterfly for some time, to study its various parts, I noted that the pulsations of its dorsal vessel had greatly increased; accordingly I placed the bulb of a sensitive Secretan thermometer (which registered 70.°5 F. in the room) against the body, and it rose quickly to 76.°5, the pulsations being forty per minute. Leaving it there, I found that when the pulsations were reduced to sixteen per minute the thermometer fell to 75.°5; and when they were apparently reduced to almost none, the thermometer fell to 75°. The next day, the chrysalis not having been again disturbed, but having rested in a glass dish on a wooden table, I again applied the thermometer about an hour before noon, the temperature of the room being 70.°25, and the thermometer rose to 71.°25, indicating, probably, the normal elevation of its exterior above the surrounding atmosphere.

Parasites. Judging from the appearance of some eggs collected in the open field, and which never hatched, this insect is attacked by a minute *Trichogramma* or *Telenomus* in the egg state, but no specimens have been reared. I have also found the nest of the caterpillar occupied late in the

season by a cluster of seven or eight white silken cocoons of some *Apan-teles*, whose operations are otherwise unknown; the caterpillar was dead and shrunk, and the parasite wintered over but never hatched.

Desiderata. Particular attention should be paid in the north to the history of this insect during the month of September. Is the second brood of butterflies a spurious one, never bearing progeny, or if so, to no purpose? Harris states that the caterpillar may be found in May; if so, it hibernates in this stage, but probably this statement is an error. The time given for the duration of the chrysalis in August rests upon limited observation and needs corroboration, and we have no knowledge of its history in the south beyond an early spring brood. Parasites of the egg and caterpillar should be sought.

LIST OF ILLUSTRATIONS.—*THORYBES PYLADES*.

<i>General.</i>		<i>Chrysalis.</i>	
Pl. 27, fig. 8.	Distribution in North America.	Pl. 85, fig. 28.	Chrysalis.
	<i>Egg.</i>		<i>Imago.</i>
Pl. 66, fig. 7.	Egg.	Pl. 9, fig. 5.	Male, both surfaces, colored.
69: 5.	Micropyle.	13: 15.	Both surfaces.
	<i>Caterpillar.</i>	35: 35.	Male abdominal appendages.
Pl. 73, fig. 5.	Caterpillar at birth.	41: 3.	Neuration.
78: 25.	Mature caterpillar, side view.	48: 3.	Scales of the male imago.
29.	Same, dorsal view.	58: 2.	Side view of head and appendages enlarged, with details of the structure of the legs.
80: 25-29.	Front views of head, stages I-V.		
86: 45.	Dermal appendage at birth.		

SECTION II.

Egg with vertical ribs much higher on the shoulder than below, the cross lines only moderately frequent, and the cells less elongated than in preceding section. *Caterpillar at birth* with the dorsal thoracic shield inconspicuous. *Mature caterpillar* with the head distinctly broader than high; frontal triangle not distinctly carinate; dorsal thoracic shield not conspicuous. *Chrysalis* with the mesonotum not so long as its greatest width; cremaster slight, elongated. *Imago* comprising species of smaller size; hind wings rounded; median forking sooner than subcostal vein on hind wing; club of antenna sickle shaped; last palpal joint linear, four or more times longer than broad. Wings fully expanded in repose by day.

GENERA: *Thanaos*. *Pholisora*, *Hesperia*.

THANAOS BOISDUVAL.

DUSKY WINGS.

<i>Thanaos</i> Boisduval, Icon. Lep., 249 (1832-1833).	<i>Nisoniades</i> Stephens (1850), nec Hübner (1816);
<i>Erynnis</i> Rambur (1858), nec Schrank. (1801);	cf. Scudl., loc. cit., 228.
cf. Scudl., Proc. Amer. acad., x: 167-168.	<i>Type</i> .— <i>Papilio tages</i> Linn.
Oh, could I fly, I'd fly with thee!	This butterfly of human breath
We'd make, with joyful wing,	Is followed fast and far by Death;
Our annual visit o'er the globe,	Some flower of life it settled on
Attendants on the Spring.	He clasps and crushes, but, 'tis gone!
LOGAN.— <i>To the Cuckoo.</i>	GERALD MASSEY.— <i>Life and Death.</i>

Imago (57: 7). Head large, profusely clothed with long, forward curving hairs, sometimes arranged to a considerable extent in transverse rows; at the outer base of the antennae a very long and slender, tapering, curving pencil of bristly hairs, fully

reaching the middle of the eye, but passing a little behind it; front a little and rather equally tumid, surpassing somewhat the front of the eyes, and rather more so below than above; it is slightly and broadly hollowed around the antennae, separated from the vertex by a scarcely impressed, straight line between the middle of the antennal bases, and is rather more than twice as broad as long; the front margin is scarcely convex, very delicately emarginate, laterally sloping off toward the outer edge of the eye, where the hinder edge meets it at a rather sharp angle; vertex almost half as long again as the front, separated from the occiput by a slightly impressed arcuate or slightly bent line; it is scarcely tumid, divided into an anterior and posterior half by a scarcely perceptible transverse ridge, which is arcuate in an opposite way to the posterior border, and in front of which the vertex just attains the level of the eyes. Eyes large, pretty full, round, naked, receding from each other posteriorly more than in the preceding genera. Antennae inserted with the hinder edge of the base at the middle of the summit, their interior edges separated from each other by about twice the width of the basal joint, the whole antenna as long as the abdomen, composed of 38-48 joints, of which 20-24, that is about half, form the club, which is nearly half as long as the stalk and bent in a curve at right angles near the middle; it is cylindrical at base and at tip, but throughout most of its length is flattened above and subtriangular; the first six or seven joints gradually increase in size until (seen from above) it is about equal in breadth to the length of three adjoining joints, and then decreases rather more gradually to the bluntly rounded tip, which is as broad as the stalk; the curve of the club is in its thickest part, and the joints in the middle of the stalk are from two to two and a half times longer than broad. Palpi heavy, fully twice as long as the eye, heavily clothed with long, loose, stiff, bristle-like scales and hairs, cut off squarely beyond the tip of middle joint, and beyond which a portion of the apical joint projects, clothed with similar but mostly recumbent scales; basal joint globose, apically as broad as long, being fullest anteriorly at the tip, but not produced into a cornute appendage; middle joint comparatively slender, cylindrical, with rounded and nearly equal ends, straight, three times as long as broad, and more than twice as long as the basal joint; apical joint minute, cylindrical, three times as long as broad, and nearly as long as the breadth of the middle joint, directed a little forwards.

Prothoracic lobes greatly appressed, laminate; when viewed from the front, broad, fan-shaped, nearly twice as broad as high, the upper edge a little arcuate, the angles rounded off. Patagia large, in length three-fourths the breadth of the head; the posterior lobe broad, more than half the breadth of the base, nearly equal, largest just beyond its base, nearly or quite three times as long as broad, and broadly rounded at the tip.

Fore wings (41:7) long, triangular, twice as long as broad, the outer margin full, the inner margin a little longer than it; the costal and outer margin very gently arcuate. Costal margin thickened for more than half its length; costal nervure terminating opposite the tip of the cell; first subcostal nervure originating opposite a point midway between the first and second median nervules, shortly before the middle of the outer two-thirds of the cell; the third and fourth nervules originating just before the extremity of the cell, the fourth extending to the tip of the wing; the second originating midway between the first and third; first inferior nervule originating from the subcostal nervure, which is bent slightly downward to receive it, as far beyond the origin of the fourth superior nervule as that is beyond the third, bent abruptly and obliquely at its extreme base, the bent portion obsolete; cross vein closing the cell apparent only by the bend of the nervules or by a slight incassation at their angle and striking the median nervule as far beyond its second divarication as the separation of the bases of the second and third superior subcostal nervules; second median nervule arising opposite the second superior subcostal nervule; first median slightly nearer the base of the wing than to the origin of the second branch and running midway between this branch and the submedian; internal nervure hardly perceptible except at the extreme base but having the same form and direction as in *Thorybes*; cell nearly six times as long as broad and about three-fifths the length of the wing.

Hind wings very broad, rounded, triangular, fully as broad as long, produced in the subcostal region so as to give a scarcely arcuate, costal margin much longer than the internal; outer margin well rounded, entire, with the least perceptible fulness at the submedian nervure; the wing roundly angulate and sub-rectangular above. Basal union of the costal and subcostal brief, enclosing a small, circular lacuna between them, their separation marked by a suture; the subcostal almost in continuation of its earliest course, forking at two-fifths the distance to the margin, united to the median nervure by a cross vein which runs parallel to the outer margin but is entirely obsolete and indicated only by the bend in the nervures at a point an equal distance beyond their last divarication; median nervure as in *Thorybes*; internal nervure diverging considerably from the submedian shortly beyond its origin, so that the tip of the median is midway between it and the lower branch of the submedian.

Dermal appendages of the male concealed in the costal fold of the fore wing (43:12; 45:2-3), consisting of long, basally pediform bristles sometimes replaced by slender, subfiliceolate, flagellate androconia or by slender, twisted ribbons; sometimes accompanied also by rod-like bristles, occasionally two-pronged at tip, and by small apple-seed androconia.

Legs 2, 3, 1; all the femora tufted beneath with a somewhat spreading fringe of delicate hairs, very long at the base of the femora, regularly and greatly diminishing in length toward the apex; middle and hind tibiae with a similar very thin fringe upon the upper surface, the hairs of nearly equal length. The males are more heavily tufted than the females. Femora 2, 1, 3 in ♀, 2, 1, 3 in ♂; tibiae 2, 3, 1; tarsi 3, 2, 1. Fore femora scarcely longer than the hind pair in the ♂, equal in the ♀, about two-thirds the length of the middle femora; fore tibiae nearly two-thirds as long as the fore femora, half as long as the middle and three-fifths as long as the hind tibiae. Leaf-like appendage of fore tibiae long and slender, more than half as long as the tibia, four to eight times longer than broad, equal, bluntly pointed at tip, a little arcuate, attached at about the centre of the tibia; other tibiae furnished at tip with a pair of very long and slender, scaled, apically naked spurs and the hind tibiae also with a similar but smaller, sometimes much shorter pair in the middle of the apical four-fifths or two-thirds of the tibiae. Tarsal joints 1, 2, 3, 5, 4, the apical fully as long as the antepenultimate joint; fore tarsi two-thirds as long as the others, which are equal and as long as the middle tibiae; all with a triple row of delicate spines beneath, the apical ones of each joint longer than the others; basal joint as long as the rest of the joints on the hind legs, a little shorter than they on the others; second joint half as long as the first on the fore legs, about two-fifths as long on the others. Claws small but moderately strong, tapering, strongly and regularly arcuate, finely pointed. Pad pretty large, circular, attached by a slender neck; paronychial slender, thread-like, nearly half as long as the claw, the tip rounded.

Second abdominal segment three or four times longer than the first, half as long again as the third, beyond this decreasing regularly, the eighth segment broadly produced above in the male to a convex, entire, rounded plate, the whole fully three times as long as the preceding segment, and furnished with very long scales; the side pieces (claspers) of the male are fringed with numerous, not very long hairs and covered profusely with short scales and are long and slender, directed a little upward and apically inward. The upper organ varies exceedingly in shape and proportionate size; centrum gibbous, subovoid, contracted toward the tip, and bearing at the extremity a pair of hooks, occasionally consolidated, at the inferior junction of which a minute, appressed, central plate or tooth, dentiform on a side view, frequently depends; near the middle of the upper portion of the centrum, the surface is either simply a little elevated; or expanded after elevation into nearly horizontal alations; or it rises into a dorsal, usually horse-shoe shaped crest, the sides of which sometimes form conspicuous lateral expansions, the whole crest being frequently asymmetrical in elevation and lateral extension and bearing on its upper edge or surface an armature of spines; from the middle of the upper surface, lateral arms extend downward and then curve backward, meeting behind, and at their united extremities expand into a transverse, usually

broad field, the inferior armature, well provided with spines or bristles. Besides the asymmetry of the dorsal crest referred to, the lateral arms, the terminal hooks and the inferior armature, frequently partake of the same peculiarity; indeed, this element seems to pervade every part of the remarkable genital armature in this genus. With some minor exceptions, the left clasp is always more highly developed than the right, both in the configuration of the whole, and in the sculpture and armature of the details; each clasp may be divided, for convenience of description, into two parts—an upper and a lower; the upper portion is ordinarily developed as a broad lobe, armed on its upper edge with a row of very long, stiff bristles, pointing backward, not exhibited on the plate; it has a tendency to expand in two directions, forming what are called the upper and hind processes, according to their position; the lobe is generally smaller in the left clasp than in the right; and the hind process either wanting or minute in the left. The lower part of the clasp is a very long, slender, usually compressed, often twisted and invariably curving blade, frequently spined or pointed at tip, its origin marked below by a denticle; it bears, at the base of the upper edge, a short, frequently bent or curving process, ordinarily somewhat triangular in shape, and very often armed with spinules; sometimes this process is wanting on the right clasp, and it is usually more slender and frequently longer on the left than on the opposite side; at their base the clasps form a large, broad, compressed, somewhat gibbous plate of variable form.

The movement of the clasps is of course lateral, and that of the upper organ vertical; but some of the constituent parts of the latter have an independent motion, the whole central apparatus, including the hooks, having a common vertical movement upon the centrum and the central tooth a forward and backward swing upon the apical portion.

Egg. Very short, sugar-loaf shaped, the sides narrowing upwards but rounding very little, excepting above, scarcely broader than high, broadest in middle of lower half, the base squarely docked, its rim rounded, the summit broadly rounded, depressed somewhat in the middle; furnished with a moderate number of straight, not very prominent, vertical ribs, extending from the base to the micropyle, the surface between them depressed in regular curves; traversed also by numerous, delicate, transverse, raised lines. Micropyle rosette a little depressed, consisting of a few rather large, roundish oval or kite-shaped plates surrounding a central minute circle and bounded by a number of oval, angular cells, the outermost larger than the others.

Caterpillar at birth. Head orbicular, minutely granulated, scarcely broader than the thoracic, scarcely smaller than the middle of the abdominal, part of the body, furnished with scattered, simple, tapering, but apically expanding hairs. Body slender, equal, the first thoracic segment with a very obscure dorsal shield, furnished with a double transverse row of four equidistant bristles, besides a pair of long, forward curving, infrastigmatal bristles (86: 48-51). The abdominal segments supplied with the following series of apically expanding bristles: a laterodorsal series, anteriorly placed (supralateral in some species), becoming subdorsal and posteriorly placed on the thoracic segments; a lateral series posteriorly placed on all the segments, and in each of these two rows one bristle to a segment in each row; a suprastigmatal series directly above the stigmata, one to a segment on the abdominal and two to a segment on the thoracic segments; and an infrastigmatal series, either one to a segment placed in the middle of the thoracic segments, or two to a segment one before and one behind the middle on the abdominal segments. The bristles of the upper rows are much more expanded apically than are the others, and the long, infrastigmatal bristles of the first thoracic segment, like those of the head, are but slightly expanded.

Mature caterpillar. Head rounded, subquadrate, with full rounded sides, the summit laterally angulated, and forming by the slight median excision of the centre a slightly elevated, lateral, submamillate prominence, made more conspicuous by the greater elevation of the minute tubercles which in some species stud the whole surface of the head, and in all are distinct at this point; head produced slightly below the middle, the lower part very full, much deeper below than above, the front well rounded on a

side view, with a posterior narrow collar which is more or less excised, sometimes almost completely severed in the middle above, covered with a delicate and very sparse pile of fine, short, simple, tapering hairs. Ocelli six in number, four subequidistant, in a curve forming the arc of a circle of which the sixth ocellus is the centre, the fifth being situated directly beneath the sixth, and lying with the fourth and sixth at the angles of an equilateral triangle; it is placed near the posterior outer corner of the antennal socket; the ocelli are subequal in size but the third counting from above is the largest. Third antennal joint very small, cylindrical, three times as long as broad, the bristle more than twice its length.

Body largest at the third, fourth and fifth abdominal segments, tapering with considerable uniformity in either direction, but more rapidly at each extremity, the first thoracic segment being considerably but not conspicuously narrower than the head, with an entirely obscure dorsal shield, and legs scarcely, if at all, smaller than the other pairs. Last abdominal segment well and rather strongly rounded apically, fringed rather closely with moderately long hairs. Segments of the abdomen divided into four subsegments, the anterior the widest, and as wide as the rest together, the three posterior subequal and occupying only the hinder half of the segment, the broad anterior one with a dorsal division separating off a posterior portion of the same width as the hinder sections, all covered profusely with minute, low papillae bearing very short hairs, tapering to a point (the apically expanded bristles being lost after the assumption of the fourth stage) and arranged in transverse series on the shorter sections only, because, from their avoidance of the incisures, there is hardly room for more than one or two rows of them. Body furnished also with a laterodorsal series of chitinous annuli, placed in the middle of the anterior half of each segment of the body, a laterostigmatal series of similar annuli directly above the stigmata, and a ventrostigmatal series, two to a segment, near together in advance of and behind the middle. Inferior gland of the first abdominal segment small but distinct and transversely sulcate. Stigmata long oval, slightly elevated, delicate. Legs slender, gently tapering, the claws fine, strongly curved, heavily beaded. Prolegs short, rapidly tapering, apically broadly ovate with a complete double row of outward curving hooklets which are very small, not very delicate, nor very sharply pointed, but taper throughout.

Chrysalis. Head somewhat distinct from the thorax, the ocellar field being subglobose, prominent, and the anterior extremity between the eyes independently and considerably tumid, accentuating their prominence, the whole broad, scarcely depressed. Thorax moderate, tumid and regular above, basal wing tubercles slight, but enough to make the thorax just wider than the eyes, faintly and obliquely carinate in nearly the direction of the antennae. The upper surface of the head and thorax to the summit of either forms a straight, unbroken line, when viewed laterally, with a considerable slope at an angle of about 45° with that of the lower surface as far as the swollen, apical half of the wing cases where the body is largest. On the abdomen on the contrary the upper surface is straight, or scarcely concave from the height of the thorax to the last segment, while the under surface continues the posterior curve of the wing covers, curving rather strongly upward apically, so that the whole lateral aspect of the chrysalis is that of a broad, sigmoid curve. Viewed dorsally, the body is nearly equal from the basal wing tubercles to the middle of the abdomen, with a scarcely perceptible constriction at the middle of the wings, and a distinct, though slight and broad enlargement on their apical half; the apical half of the abdomen tapers rapidly. The thoracic spiracle-guards are moderately large, semi-lenticular. There is no mandibular tubercle. The second pair of legs extends a little beyond the base of the antennal club, the third pair somewhat beyond the antennal tips, which are finely pointed; and the tongue a little beyond the wings and almost to the tip of the fourth abdominal segment. Spiracles oval, nearly twice as broad as long, not prominent. Cremastral spine pyramidal, truncate, rudely quadrilateral, longitudinally and irregularly sulcated, the hooklets half as long, forming a flaring bunch.

Distribution. This genus of butterflies is peculiar to the north temperate zone, and is rich in species—far more so in the New than in the Old World, as we should expect from the occurrence of all the more closely allied genera in Central America alone. In the Old World it extends from the thirty-fifth to the sixtieth parallel, in America from the twenty-eighth to the fiftieth. In both it extends from ocean to ocean, and from the plains to a considerable height upon mountain sides—in the Alps to 5000, in the White Mountains to about 3000, in the Rocky Mountains to perhaps 9000 feet. A portion of the species found upon the east and west coast of the Old World have been described as distinct, but the best known, *tages*, is said to be common to the two shores. In North America nearly all the species of the west coast, and they are almost equally numerous with those of eastern America, although not all described, are distinct from the species on the other side of the Rocky Mountains, while many of the latter extend north and south over the whole width of the belt in which the genus occurs.

Of the New England species*, two or three have been found across the continent and several of the others extend to the Great Plains. All extend as far south as Georgia, and all but one to Florida. Two only are known to extend to the northernmost parts of New England the others being confined to the southern half. The species resemble each other very closely, and require the closest study for their determination.

General characteristics of the butterfly. The upper surface of the wings is very dark brown, the hind wings uniform and immaculate excepting where some of the spots of the under surface are faintly reproduced above; the fore wings generally grayish, often flecked with hoary scales, especially in the outer part of the wings, and blotched obscurely with blackish and cinereous; three transverse dark bands cross the wing, the outer a submarginal one, generally formed of independent roundish spots less distinct and not so dark as the other markings, the inner, an intramesial band, which starts from the tip of the costal nervure, and generally is but vaguely defined, especially below, and is often wholly merged in the blackish blotching of the base; the middle is an extramesial, arcuate or sinuous series, including some vitreous spots next its inner margin, and is composed of more or less triangular, longitudinal, usually confluent dashes, pointed outwardly; the vitreous spots are small and consist of four submarginal ones in the narrow subcostal interspaces, two median ones, one in the upper part of the cell near its extremity and one in each of the interspaces beyond the cell; the latter are usually absent and most of the others may be obsolete, the only persistent ones being those in the middle submedian interspace, and generally those in the upper median.

The butterflies are of moderate size for Hesperidae, have ampler wings than any other genera excepting those immediately contiguous, and the

* Omitting mention of *T. ausonius*, not yet really found within its limits.

scales seem to be more feebly attached, since the wings are very easily abraded. The bunch of short, conical filaments which nearly fills the opening of the prothoracic spiracles can be protruded to a considerable distance so as to form a prominent tubercle-like swelling, which I have not noted as possible in other genera of Hesperidi.

Some structural peculiarities of the butterfly. One of the most remarkable features in the structure of the butterflies of this group is the extensive and asymmetrical development of the abdominal appendages of the male, which was first pointed out in the common European species by Rambur, but until recently has escaped further observation. The same asymmetry is found in some of the neighboring genera, such as *Achlyodes*, etc., and doubtless in some other groups, since I have detected it in a *Heliconiceus* butterfly. It does not, however, occur in any other New England butterflies, except in a very inconspicuous degree in some of our other Hesperidae. The asymmetry is not only found in the lateral valves, which are sometimes of widely disproportionate size, and serve well, also, to distinguish the different species, but often also above, in the central hook, the posterior view of which shows it to be sometimes remarkably lop-sided.

One reason, doubtless, that this strange asymmetry has escaped observation, is the entire concealment of the parts by scales, to which may be added the want of attention to these appendages in butterflies;* the upper organ is protected by an extensive posterior expansion of the terminal segment of the abdomen, which forms a projecting hood, and which is also provided at tip with a heavy fringe of excessively long scales; the clasps are themselves furnished externally with a heavy coating of pretty long scales, which effectually hides the sculpture of the parts; although the disparity in length of the two clasps is readily seen, when it is so marked as it is in *T. brizo*.

In endeavoring to assign a reason for this excessive development and remarkable asymmetry of the external genital organs, one cannot but be struck by the fact that the males of this genus are far more commonly met with than the females; whether this is due to the comparative scarcity of the latter, or to the greater seclusion of their haunts—all the species are sylvan—I am not prepared to say; the females, however, though more radically sylvan, are constantly taken in the same stations as the males, so that I am inclined to adopt the former hypothesis and to believe that, notwithstanding the simplicity of the external genital apparatus in the female, the excessive development of these parts in the male is in correlation with their superior numbers, ensuring, beyond doubt, the impregnation of every female; I do not, however, see how asymmetry gives any superior ad-

* Now that Gosse, Buchanan White, and Godman have directed attention to the systematic value of these parts, this reproach will no longer be possible.

vantage. It may be mentioned in this connection that when a male of one of these species is taken between the fingers, the insect frequently endeavors to use this apparatus as an organ of defence, or perhaps it might be said, of aggression, much after the manner of a *Panorpa* or a *Staphylinus*.

An examination of the androconia concealed in the costal fold of the fore wing in the species of this genus has brought to light some very curious facts, showing how closely, as far as these scales are concerned, some of the species are related to each other and how very distinct some that were supposed to be doubtfully separable. This has led to some further examination of the eccentric abdominal appendages of the males, and to a new arrangement of the groups proposed by Mr. Burgess and myself (*Proc. Bost. soc. nat. hist.*, xiii: 282-306, pl.) when we first described these organs. The table given on a subsequent page brings out the more striking features and arranges the New England species in a more logical order than before; a new distribution of the species will be found in the text. *Ausonius*, a somewhat anomalous species, is included here because found upon the confines of New England. The only known specimen having been only partially examined (Mr. Lintner kindly permitted me to remove enough scales to study the more prominent characteristics), it is impossible at present to locate it with precision.

Life history and habits. These butterflies are among our very earliest species, being preceded only by a few *Lyceninae*, and in this respect differ widely from most of our other *Hesperidae*, but few of which appear until a month later. Some of the species are single, some double brooded, and one even in part triple brooded, but the second generation of the double brooded species seem to be generally far less numerous in individuals than the first; the chrysalids producing the second brood eclose the imago in a week or ten days, while those giving birth to the early spring butterflies continue in this state from three to six weeks, the larva always hibernating full fed and changing at the first indication of the lessening rigors of winter. In this and the neighboring genera we have, I believe, the only instances among *Lepidoptera* in which very early imagos have hibernated in the caterpillar state. The eggs are laid singly and the caterpillars live isolated in little nests which are made upon the under side of leaves either by cutting and folding over a fragment of the leaf, and fastening it securely to the other portion by strong distant bands of silk, or by uniting several leaves. These nests are always scrupulously clean; the whole interior of the nest is lined with silk and this is always sufficiently large to permit the inhabitant to turn about. The caterpillars of some species eat little irregular holes or slits upon either side of their nest, and this becomes a ready mode of discovering the insect.

The caterpillars feed mostly upon leguminous plants, but not infre-

quently on Cupuliferae and Salicaceae and even on Ranunculaceae, Hamamelaceae and Chenopodiaceae in this country and on Cruciferae and Umbelliferae in Europe;* besides those mentioned under the different species below, undetermined kinds have been found by Dr. Chapman upon other plants of the same family, such as *Lespedeza hirta* Ell., *Sesbania vesicaria* Ell., *Clitoria mariana* Linn. and *Centrosema virginianum* Benth; I have found eggs of one species on *Robinia*.

The insects appear to change to chrysalis within the last larval nest or in another entirely similar one constructed for the purpose, but in either case the nest is more perfectly closed.

Of the butterflies the female is always less abundant and seldom or never leaves its natural haunts,—overgrown recent clearings or the thickets and woods themselves; while the male is more fond of the neighboring roads, playing about damp spots and resting with spread wings, with a tameness apparently quite foreign to its nature in the thickets. In the woods, these insects roam about with a jerky flight, never far from the ground but with so uncertain a movement and such frequent changes of course that they are rather hard to capture, and the nature of their haunts among the thickets does not lessen the difficulty. They skip into this and that corner and natural arbor as if on the search for what was going on; apparently about to alight on every stick they meet, they seem to find it unsatisfactory as soon as reached and avoid it with a start. How they manage to fly with such irregularity and speed through dense shrubbery is hard to understand. They do not often seek the juices of flowers but are occasionally taken on those of everlasting.

When resting at night they close their wings quite in the manner of a noctuid moth. Frohawk once found the European tages asleep on a grass head (87: 22) the fore wings entirely covering the hind pair and sloping like the roof of a house; the head at the same time was bowed so as to touch the grass and the antennae were bent *back* parallel with the costal margin of the wings. The colors of the butterfly were wonderfully similar to those of the grass head, and coupled with the position assumed on the brown tuft was a remarkable and perfect disguise.

The eggs are very short, sugar-loaf shaped, with a moderate number of vertical ribs throughout their length. They are laid singly, sometimes upon the upper, sometimes on the under surface of leaves, on the stems of plants, or as Boissduval says is the case with *T. tages* of Europe, under the petioles of the leaves. The larvae are exceedingly sluggish in habits, with strongly constricted collar, large head, plump and somewhat arched body, pale green or yellow, with a few longitudinal stripes of different shades of the same color and a concolorous dorsal shield on the first thoracic segment. The chrysalids are not so stout as in the preceding genera

* Stoll[†] figures a South American species on a *Solanum*.

but are otherwise of similar form, generally of some shade of green with dusky clouds.

"Dr. Curtis mentions the curious circumstance, that old specimens [of this genus] when alive have frequently lost one or both of their palpi, an accident he had only observed among the *Pyalidae*" (Westwood, *Modern class. ins.*, ii : 360).

A fossil butterfly has been found in the miocene of Rott, Germany, closely allied to this genus.

EXCURSUS LVII.—NESTS AND OTHER STRUCTURES MADE
BY CATERPILLARS.

Unweave the Caterpillar's gluey thread.

DARWIN.—*The Botanic Garden.*

THERE is considerable difference among the caterpillars of butterflies as to the amount of silk they spin. Some, and this is especially true of the *Lycenidae*, and next of the *Pierinae*, spin very little and have apparently little use for it, being able to make their way about without weaving a carpet whereon to cling, though they ordinarily do spin some. Others seem unable to take a single step without laboriously spinning a thread wherever they would go, fastening it upon this side and that, and without it will venture nowhere. As a general rule nests of any sort are constructed only by the last named, i. e., by those most dependent upon a hold on silken strands to make their way. Yet there is one notable exception in a Mexican *Pierid* which constructs a web nearly as close as parchment.

Nests, which are almost solely for purposes of concealment, are very generally made by those butterflies whose caterpillars are gregarious, but there is one kind made by New England social caterpillars which has no such purpose and which is perhaps too simple to be properly called a nest. This is the web made, particularly in earlier life, by the caterpillars of *Eu Vanessa antiopa*, which move about much from place to place, spinning wherever they go, so that at last the line of movement by successive strands thrown across every angle a twig makes with the larger stem, forms a sort of veil of silk over which they crawl with extreme rapidity, but without which their movements are greatly retarded.

Some caterpillars have a favorite place of repose to which they come after every meal and which they carpet with silk for greater comfort. Of such are some of the swallow-tails, and it would seem as if the nest they construct were at first an accidental result of this habit, perfected by its protective adaptation. These caterpillars rest upon the middle of the upper surface of a leaf, upon the floor of which they have stretched a silken carpet from side to side, each strand shorter than the last, so as to make the

edges curl toward each other and sometimes to meet and thus to form an open nest.

The most common form of nest, however, is that in which different parts of the same leaf or adjacent parts of different leaves are fastened together by silken strands. The simplest and weakest of these are made by the caterpillars of *Polygonia faunus* and *Vanessa atalanta*, which fasten together very weakly the opposite edges of a single large leaf so as just to make them meet; but the threads are so slight that they are ruptured with the slightest effort. The caterpillar within having thus secured a shelter seems loth to leave it and makes its meals from its own dwelling, until having literally eaten itself out of house and home it is forced to venture forth and construct another.

Another form of nest made from a single leaf is constructed by all the higher skippers, *Hesperidi*, in early life, and by many of them throughout life, by folding over a little piece of leaf, and fastening the edge to the opposite surface by a few loose strands of silk; to effect this they first bite a little channel into the leaf at just such a place as to leave a fragment of leaf neither too large nor too small to serve as a roof when they shall have turned it over; often they have to cut two channels in order to procure a flap sufficiently small for their purposes; and it is curious to watch one of these tender creatures, just as soon as it has devoured its egg-shell, struggling with a tough oak-leaf to build for itself a house. These nests are much more firmly made, the silken fastenings being composed of many strands often very tough. On leaving one nest to construct a larger, the caterpillar always, I believe, first bites off the threads of the old nest and gives the flap a chance to resume its position, which however, it rarely fully does. When older many of these same skippers find a single leaf of their food-plant too small to conceal them, and so they draw several leaves together just as they grow upon the plant, and retaining them in the desired place by silken bands, live within the leafy bower. This mode of construction is adopted almost from the first by the *Pamphilidi* which feed on grasses, the proximity of adjoining blades near the base affording a good chance to attach them together, while a cluster of blades furnishes a similar chance to construct the somewhat tubular nest they require when they have grown large and fat.

A nest composed of several leaves is not made by many other of our butterflies. *Vanessa atalanta*, however, especially when it is more than half grown, finds it easier to attach neighboring leaves of the thickly growing nettle, than to find one sufficiently free to use it only; so that fully one-half of the nests of the larger caterpillars are made from a number of leaves; the nest is always roomy, capable of housing several caterpillars, though never containing more than one.

The nesting habits of *V. atalanta* are shared by the other species of

Vanessa, with certain slight variations. In early life, *V. cardui* tries to make the stiff and crenulate edges of thistle leaves meet together, but with indifferent success, and so fills in the interstices with an exceedingly thin web, in no way concealing it from sight. In after life it forms an oval nest of the size of a pigeon's egg, by fastening adjoining leaves together very slightly, and filling all the interstices with a similar, flimsy web, upon which it fastens, or into which it weaves, bits of eaten leaf or parts of the inflorescence of the plant, still imperfectly concealing it from sight; and sometimes it hangs itself up for chrysalis within the same narrow, and by this time very filthy apartment. *V. huntera* makes a similar but rounder nest on the everlasting, and conceals itself very effectually by completely covering the more compact, but still very slight web, with the inflorescence of the plant.

Another class of nests is that made by some of our *Melitaeidi* (*Cinclidia* and *Euphydryas*) which, living in company, cover at first a few leaves, then the whole head of the plant, and eventually, sometimes, the whole plant in a tolerably firm web, within which the company feed, until the whole becomes a nasty mess of half eaten and drying leaves, and all sorts of frass, including their own excrement and cast-off pellicles, everywhere tangled with web. Within such a nest they hibernate, but not until they have strengthened it with denser web and drawn the leaves of the head more tightly, so that it becomes a mere bundle which one may cover with his hand, and which contracts the more, apparently, as winter approaches. In the spring they evidently have had enough of this sort of communal life, and live thereafter in the open air.

But perhaps the most interesting nest of all is that made by the caterpillar of the viceroy. This caterpillar hibernates when partly grown, and provides for the occasion a winter residence, which is occupied only during the cold season. For this purpose it eats the sides of a willow-leaf nearly to the midrib, for about one-third the distance from the tip, ordinarily selecting for the purpose a leaf near the end of a twig; the opposite edges of the rest of this leaf it brings together, and not only fastens them firmly with silk, but covers this nest outside and inside with a carpet of light-brown glossy silk, so that the leaf is nearly hidden; nor is this all; it travels back and forth on the leaf-stalk and around the twig, spinning its silk as it goes, until the leaf is firmly attached to the stalk, and in spite of frost and wind will easily hang until spring. Following the projecting midrib, the caterpillar creeps into this dark cell, head foremost, and closes the opening with its hinder segments, all abristle with spines and warts. The other species of the same genus, the red-spotted and the banded purple, have the same habits; the latter feeds on birches, and if we examine these trees in early spring, when all sorts of ichneumon flies are just beginning to wander about in search of prey, we can hardly fail to be

struck by the deceptive resemblance these hibernacula of the banded purple bear to the opening buds and curving terminal shoots of the very twig on which they occur; the color of the soft down of the buds and the enveloping silk of the hibernacula is as similar as are their forms; and this mimetic resemblance is doubtless as effective as it is interesting.

Table of the species of Thanaos, based on the imago.*

Fore wings with subapical vitreous spots. Terminal hooks of upper organ of male genitalia separate; blades of clasp long, especially on left side, when compared to the main body; hind process of right clasp smooth. Costal fold of fore wings of male furnished with long pediform bristles, curving at base, but with no flagellate or twisted androconia.

Species of smaller size (wing expanse less than 38 mm.). Summit of upper organ of male abdomen with no bristling crest; basal process of left clasp unarmed; the blade very slender. Costal fold with many long, rod-like, subequal androconia, sometimes two-pronged, apically not twice so stout as at base.

The dark spots of the upper surface of the wings neither well defined nor in striking contrast to the ground color. Extremity of the blades of the male clasp only slightly curved; pendant tooth of centrum reduced to a bristle. No apple-seed shaped androconia in costal fold.

A large, somewhat distinct patch, paler than the ground color between the cellular and subcostal vitreous spots of the fore wings. Process of left clasp of the male slender and straight, almost as slender as the blade; basal process of right blade tapering nearly to a point. The smaller scaphiform scales of the costal fold often no more than twice as long as broad.....*lucillus*.

A patch like that mentioned above, but faintly or not at all indicated by contrast. Process of left clasp of the male broad and curving strongly, much broader than the blade; basal process of right blade broadly rounded. The smaller scaphiform androconia rarely or never so short as above.....*persius*.

The dark spots of the upper surface of the wings well defined and in striking contrast to the ground color. Extremity of blades of male clasp bent strongly; pendant tooth of centrum stout. Many apple-seed shaped androconia in costal fold.....*martialis*.

Species of larger size (wing expanse more than 40 mm.). Summit of upper organ of male abdomen with a distinct prickly crest; basal process of left clasp armed with spinules; the blade moderately slender. Costal fold with no rod-like, subequal androconia, the nearest being much more than twice as stout at tip as at base; the different species of this group show no distinction in androconia.

Upper surface of fore wings flecked with whitish scales throughout, so as to be quite different in general tint from the hind wings. Crest of upper organ of male genitalia slightly elevated and bearing a vertical shield expanding apically; lobe of right clasp dactylate, long, slender and free, curving inward.....*juvenalis*.

No such difference as indicated above between the fore and hind wings, except in small patches. Crest of upper organ of male genitalia with the armature facing upward. Lobe of right clasp either very broad or not separate from the blade.

No such patch as indicated below in any part of the wing. Crest of upper organ of male abdomen strongly elevated and surmounted by a horse-shoe shaped ridge; lobe of right clasp greatly expanded, broadest apically.....*horatius*.

A distinct patch, at the extremity of the cell and above it, paler than the rest of the wing. Crest of upper organ of male abdomen forming a gibbous prickly protuberance; lobe of right clasp greatly expanded, broadest basally.....*terentius*.

Fore wings with no subapical vitreous spots. Terminal hooks of upper organ of male genitalia [ausonius? unknown] consolidated and stout; hind process of right clasp [ausonius? unknown] denticulate. Costal fold of fore wings of male [ausonius? unknown] with no pediform bristles, but with either flagellate or twisted androconia.

*The early stages of our many species of Thanaos are insufficiently known for any attempt at tabulation, though partial tables

could readily be made for some of them.

†Ausonius will doubtless be found to agree closely with martialis.

Extra-mesial band of fore wings removed by less than its own width from the apex of the cell.
 Blades of clasp of male abdomen long as compared to the main body, strongly bent at extremity.....*ausonius*.

Extra-mesial band of fore wings removed by more than its own width from the apex of the cell. Blades of clasp of male abdomen short as compared to the main body, not bent strongly at apex.

Species of moderate size. No distinct hoary patch between the upper halves of the two bands crossing the upper surface of the fore wings; no hind tibial pencil of hairs in the male. Blade of right clasp stout; tip of right clasp broad and denticulate. Costal fold of fore wings with twisted ribbon-like scales.....*brizo*.

Species of small size. A distinct hoary patch in the position indicated above; a long hind tibial pencil of hairs in the male. Blade of right clasp slender; tip of right clasp slender and smooth. Costal fold of fore wings with flagellate tapering scales.....*lucilius*.

GROUP I (*lucilius*).

Antennal club composed of not more than eighteen joints; fore wings with subapical vitreous spots; hind coxae of male with an auriculate process, and hind tibiae with a basal interior pencil of hairs longer than the tibiae; costal fold with both pediform bristles and rod-like androconia; upper organ of male abdominal appendages without a crest; terminal hooks separate, slender; tooth reduced to a tubercle and bristle; clasps with slender blades, the left with separated basal and median processes, both unarmed. Eggs with less than fifteen, rarely as many as fourteen, vertical ribs. Larval food, Ranunculaceae and Salicaceae. Two or three broods annually in the northern United States.

SPECIES: *lucilius*, *persius*.

THANAOS LUCILIUS.—*Lucilius's dusky wing*.

[Five spotted banded skipper (Maynard).]

Nisoniades lucilius Lintn., MS., Scudd.-Burg., Proc. Bost. soc. nat. hist., xiii: 287-288, pl. fig. 2, u, l, r (1870);—Pack., Can. ent., iii, vi: 113 (1871);—Lintn., Ent. contr., i: 32-34, pl. 7, figs. 1-2 (1872); ii: 60-61 (1872); iv: 67-68 (1878);—French, Butt. east. U. S., 357-359 (1886).

Erynnis lucilius Scudd., Syst. rev. Am. butt., 51 (1872).

Thanaos lucilius French, Rep. ins. Ill., vii: 161-162 (1878);—Mayn., Butt. N. Engl., 54, pl. 7, figs. 78, 78a (1886).

Nisoniades persius var. *lucilius* Streck., Cat. Amer. Macrolep., 178 (1878).

Figured by Glover, Ill. N. A. Lep., pl. T, figs. 3, 15, ined.

Welcome, maids of honor,
 You do bring
 In the Spring,
 And wait upon her.

HERRICK.—*To Violets*.

"Doch sag'! was ist's mit den Schmetterlingen?"
 Die starben der Rose nach aus Schmerz.
 Die Elfen nahmen die bunten Schwingen
 Zum Putz für die Damen bei Tanz und Scherz.

SALLEY.—*Elfenwirthschaft*.

Imago (9:4). Head covered above with long, maroon or purplish brown hairs, mingled with a few paler, sometimes ashen gray hairs in front; beneath, the scales are paler and a few pass around the hinder edge of the eye; tuft of bristles outside of the antennae black. Palpi pale purplish brown beneath verging on ashen, especially toward the basal joint, and pretty uniformly pale-tipped, even to a slight extent above, where it is otherwise considerably darker; outer surface covered rather abundantly with long black hairs; apical joint blackish brown, beneath flecked with grayish.

Antennae blackish brown, very minutely flecked with whitish at the base of the joints on the apical half of the stalk above; and below distinctly marked with snowy white at the base of all the joints, posteriorly extending upon the club, where it forms a long field growing dirty yellowish toward the tip, the division of the joints faintly marked with dusky; the anterior surface of the club naked and deep castaneous, sometimes deeply infuscated above; the apical joint luteo-castaneous. Tongue blackish fuscous, becoming castaneous apically, and at extreme tip changing to luteous.

Thorax covered above with blackish brown hairs and scales tinged with purplish; beneath with dark, slightly olivaceous, brown hairs, often ashy. Legs dark purplish brown, darkest on upper surface of femora and tibiae, the sides of femora and under surface of tibiae often tinged more or less conspicuously with silvery gray or dirty yellow, nearly always with some shade paler than the upper surface, the inner sides of the tarsi, especially toward the base of the joints, and the under surface toward the base cinereous. Spurs dark brown, sometimes flecked with gray next the leg, reddish tipped; spines bright reddish luteous. Claws the same, dusky edged and tipped. Pad dusky or blackish.

Wings above. *Fore wings* dark grayish or cinereous brown, a very little darker in the ♂ than in the ♀, heavily marked with black or blackish blotches and bands. The cellular vitreous spot just beneath the base of the second superior subcostal nervule is seldom present in the ♂ and often absent from the ♀; in the latter only is it ever as large as the other spots; these form a bent or curving broken series composed of subcostal and median spots, none being ever present in the interspaces beyond the cell; the subcostal spots are placed in succeeding interspaces below the second superior subcostal nervule in a nearly or quite straight line running from the costal margin, scarcely within a point midway between the tip of the costal fold of the ♂ and the tip of the wing, to the middle or just below the middle of the outer margin; they are four in number, although all but the second from above may become obsolete and they are always minute, especially in the ♂; occasionally both and very often the lower of the median spots are absent, especially in the ♂; the upper is placed just before the middle of the upper median interspace, and the lower, when present, is almost invariably farther from the border than the upper but not more so than in *T. persius*. The basal half of the wing above the lower median nervule and the basal third or two-fifths below it is heavily clouded with black, more or less blotched in the lower half of the wing with dark cinereous; the outer limit of this field is more distinctly marked in the ♀ than in the ♂ and, starting from the tip of the costal nervule, is at nearly right angles to the costal border, as far as the lower median nervule, below it arcuate, opening outward. Beyond, the decided cinereous tint of the wing is more manifest, often tinged to a very slight degree, especially in the ♀, with purple; in the upper half of the wing and sometimes toward the outer border (especially in the ♀) the gray tint is more distinct than within the lower half of the extra-mesial band; especially is this the case between the cellular, ochreous spot and the outer series of similar markings, where the whole roundish space from close to the costal edge to the bottom of the cell is occupied by a distinct gray flecking, forming, generally, with the darker markings bordering it, a more conspicuous contrast than occurs elsewhere on the wing; in the upper half it is often powdered slightly with whitish or lilaceous scales; the extra-mesial band is sometimes narrow, sometimes moderately broad, in the former case composed of rounded triangles, in the latter of lanceolate dashes, pointed outward; it is of uniform width, generally regularly arcuate, occasionally bent near the bottom of the submedian area and encloses at its edge above, in its middle or the middle of its inner half below, the subcostal and median vitreous spots; the spots of the band are narrowly bordered externally with pale cinereous markings, often flecked, at least in the upper half of the wing, with hoary scales, which sometimes extend over the whole outer border excepting the submarginal spots; the latter are dusky, roundish, often lunulate below, usually at least partially confluent, increasing slightly in size and scarcely receding from the outer border in passing downward; they are generally fol-

lowed exteriorly by pale dots or spots, occasionally by delicate, very short, pale lines uniting them to the outer border, which is edged with blackish. Fringe nearly uniform dark grayish brown, the basal portion flecked with hoary scales. *Hind wings* very nearly uniform, soft, blackish brown, tending to fuliginous; a marginal and extra-mesial row of spots, the latter in the middle of the outer two-fifths of the wing, are distinct only in the ♀ and there consist of small, roundish, pale cinereous spots, occasionally arrow-headed, the extra-mesial row sinuous; in the ♂ they are sometimes entirely obsolete, or the marginal series when present is quite inconspicuous: outer border edged with black as in the fore wings; fringe dark cinereous, a little lighter than on the fore wings, duskiest toward the base, at extreme tip, especially above, a little whitish.

Beneath dark fuliginous brown, with a slight purplish tinge. *Fore wings* very pale ochraceous or cinereous along the inner margin, fading out on the adjacent parts. The vitreous spots exactly repeated beneath; outer portion of the wing with two transverse rows of very pale ochraceous or whitish spots, the outer composed of smaller, usually more distinct and whiter, marginal spots, dots, or rarely short longitudinal lines, occasionally obsolete in the ♂; the inner of short, longitudinal, cloudier, pale dashes in the middle of the outer two-fifths of the wing, fainter in the ♂ than in the ♀, and in the former occasionally obsolescent; the spots of both rows increase in size in approaching the inner border, and finally merge in the pale field of this portion of the wing; the extreme apex of the wing is more or less heavily flecked with grayish or hoary scales, generally extending a little on the fringe of this part of the wing; outer margin edged with black; fringe slightly grayer than the ground color of the wing, faintly paler at the extreme base. *Hind wings* with a double row of always small, pale ochraceous spots, more distinct and larger in the ♀ than in the ♂, and in the latter often obsolescent; the outer are seated on the border and are usually reduced to short longitudinal lines in the middle of the interspaces; the latter form a slightly sinuous row in the middle of the outer two-fifths of the wing, and although sometimes roundish, are very often, even in the ♀, reduced to lines like those of the marginal series or even shorter; and when roundish are usually more intense along the middle. Outer margin and fringe as in the fore wings.

Abdomen above blackish brown, the tips of the segments grayish; beneath flecked with brownish gray. Male appendages (36: 4-6) with the *upper organ* very similar to that of *N. persius*, differing in being shorter, having shorter terminal hooks; a larger proportion of the cup, forming the union of the lateral arms, seems to be covered with the inferior armature, as it extends almost to the base of the bent portion of the arms. *Left clasp*: Main body pretty small, slender, straight, slightly convex laterally, increasing rapidly and pretty regularly from the base, forming a high triangle, whose apex is at the base of the piece. Blade pretty broad at the base and directed a little downward, decreasing rapidly in size, and then uniformly slender, very long, curved backward, slightly upward and considerably and regularly inward, scarcely compressed, its outer surface twisted slightly in the apical half so as to become nearly horizontal and uppermost, very bluntly rounded at the tip, the upper inner angle a little produced; basal process digitate, attenuated, incurved, bowed upward, not compressed, slenderest at the base, rounded at tips, a little more than one-third as long as the blade. Lobe forming a slightly longer, broad, nearly equal, flattened plate, a very little narrower and very broadly rounded at the tip, curved slightly inward and twisted a very little, tending to bring the outer surface uppermost. *Right clasp*: Main body like that of the opposite side. Blade similar in size, length, form and direction to the left clasp, but not so broad at the base, equally rounded at the tip and armed apically with a very few minute, inconspicuous spinules; basal process reduced to a slight, pointed, triangular tooth, connected with the blade by a slight ridge. Lobe very large and broad, reaching downward beyond the base of the blade, fully half as long as it, rounded at tip, directed backward and a little upward, gibbous, curved inward a little more than the blade, the tip bent suddenly upon itself and directed straight forward, the bent apex and incurved lower edge armed, the former with a few very long, the latter with more frequent shorter, minute spinules.

Measurements in millimetres. Length of tongue, 8 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wings.....	12.85	15.35	18.15	13.5	14.75	16.
antenna.....	6.75	7.0	8.9	6.8	7.5	8.
hind tibiae and tarsi..	5.25	6.25	7.6	6.15	6.15	6.8
fore tibiae and tarsi..	3.0	4.15	4.9	4.	4.15	4.5

Described from 21 ♂, 8 ♀.

Accessory sexual peculiarities. The costal fold of the fore wing of the male encloses a mass of clustered pediform bristles (47: 4a) about .65 mm. long; scaphiform androconia of varying lengths (4 b, e) often no more than twice as long as broad, seated upon the costal vein; stout, rod-like androconia (4 d), occasionally two-pronged at tip; others similar, but laminate (4 c) and perhaps only slender forms of the usually thin, widely expanded and more or less irregularly, round, oval cover-scales (4 f).

Egg (66: 14). Broad, slightly narrowing as it passes upward, the summit very broadly rounded; sides furnished with from twelve to fifteen distinct ribs, compressed, not very high, passing from extreme base to or nearly to the micropyllic depression in a slightly sinuous or tortuous course; when they stop short of this depression a new set of ribs starts between the others, one to every two or three of those below, generally one in the middle between a pair; but sometimes closer to one than to the other, and rarely directly continuous to the depression itself; the vertical ribs are connected by frequent, very delicately raised straight lines, at equal distances apart, occasionally near the shoulder of the egg a little oblique, separating cells about seven times as broad as long; the whole surface densely punctate. The micropyllic depression (69: 3, 6) .2 mm. wide; the central micropyllic cells smooth, not punctate, rounded cuneiform, about .065 mm. in length; outside of these smooth cells the surface is at once punctate, and the cells very delicate and obscure, hexagonal, their longer axes diverging. Color at first of a green so delicate and pale as to be almost white, afterwards turning to a pale salmon color. Height, .65 mm.; greatest breadth, .65 mm.; the vertical ribs at most .16 mm. apart, .03 mm. high in the middle; the transverse lines .025 mm. apart.

Caterpillar. First stage (73: 2). Head (80: 31) blackish chestnut brown with black ocelli and white hairs, the mouth parts concolorous. Body very pale greenish yellow, the dorsal shield of first thoracic segment merely dusky, legs and prolegs concolorous, the claws of former luteo-castaneous. Length, 2 mm.; breadth of head, .45 mm.; clubbed bristles, .025 mm. long.

One specimen obtained from eggs collected in the field had a colorless or albino head, but it was evidently a sign of some deficiency as it died without eating.

Second stage. Head (80: 32) a little bilobed, pitchy black, studded with fine, white or translucent hairs all very short; mouth parts and antennae black. Body of the green of the under surface of the leaf of columbine, each section of the segments with a transverse series of short, whitish hairs like those of the head; dorsal shield of first thoracic segment whitish and smooth, without hairs; legs and prolegs green. Length, 4 mm.; excepting the slenderness of the body the form is that of the adult.

Third stage. Head (80: 33) subquadrate, larger than the next segment but smaller than the middle of the body, the upper outer angles produced to a slight stellate tubercle or rather to four or five projecting blunt points; upper margin roundly excised; black, made hoary by abundant short, white hairs. Body grass green or the green of the upper side of the columbine leaf, the sides paler and tinged with yellowish; a narrow dorsal band darker green and a lateral line white with a tinge of green; a similar fainter and posteriorly obsolescent, suprastigmatal line. Beneath pale green. Whole upper surface dotted with short, pellucid, fungiform bristles (86: 46, 47) in tolerably regular, transverse series, seven or eight series to a segment, growing from pallid wartlets. Spiracles pallid. Legs and prolegs color of under surface; claws of former fuscous. Length, 7.5 mm.; breadth, 1.2 mm.

Fourth stage. Differs from the preceding stage only in size, and in that the bright spots of the head (80:34), which are so striking a feature of the mature larva, first make their appearance as a pair of small, red spots just below the summit. Length of body, 10 mm.; breadth of same, 1.5 mm.; of head, 1.7 mm.

Last stage (77:9). Head (77:8; 80:35) black, enlivened on either side by three oblique streaks or spots of dull, inconspicuous, brownish red; one, the largest and uppermost, extends from near the summit of the triangle to the upper outer angles of the head, narrowing above; the others are roundish spots, one above and slightly behind the other, occasionally united and then parallel to the uppermost on the middle of the sides of the head; the labrum is sometimes similarly colored at the base; base of the antennae and palpi livid, but the rest of the mouth parts black. Ocelli blackish fuscous; elevated summit of head crowned with half a dozen small, blunt, conical, black tubercles as broad as high.

Body green, scarcely paler than the upper surface of the columbine leaves, becoming yellowish in all wrinkles and along the lower border of the sides, so transparent that the sex is easily determinable through the skin; a slender, pale yellowish, lateral line, and owing to the transparency of the pellicle, only a darker green dorsal stripe; body profusely covered with minute, whitish wartlets, from each of which arises a minute, delicate, very short hair, as on the head, giving a pale yellowish bloom to the surface. Under surface scarcely paler green without much bloom, the legs and prolegs similar, the tip of the former a little dull luteous. Spiracles very pale luteous, inconspicuous. Length of body, 20 mm.; breadth in middle, 4 mm.; at first segment, 1.75 mm.; of head, 2.5 mm.

Another description. The following was sent me in 1872 by Mr. W. Saunders:—Head very large and prominent, nearly triangular in front, black, with a streak of reddish white from each upper corner, extending to about the middle, and shaded on sides with brown. There are also two whitish dots on each side, and one of the same immediately above the mandibles, the whole surface being roughened with minute tubercles or granulations. Body above dull pale green, with a yellowish bloom occasioned by the body being thickly covered with very minute yellow granules. A broken dorsal line of deeper green, arising from the semi-transparency of the skin allowing the viscera to show through. A faint [lateral] yellow line, with faint imperfect cross lines of the same between the segments. Along each side close to under surface the color becomes paler, with a more decided yellow tinge; stigmata small, yellowish, not visible without a magnifier. The [first thoracic] segment is much constricted, giving the head a much more prominent appearance than it would otherwise possess; it has also a narrow band of black on its anterior edge, close behind the head. Under surface pale green with fewer yellow granules, feet and prolegs green, faintly tipped with brown.

Chrysalis (85:30-32). Pale green, the wings, and to a certain extent the thorax, not so pale as the other parts; dorsal thoracic spiracles black; body covered abundantly with very delicate and short concolorous hairs; cremaster tip and crotchets testaceous. The tongue scarcely extends beyond the tip of the wings. Length, 14.25 mm.; height of thorax, 4 mm.; of abdomen, 3.5 mm.

Comparisons. This butterfly and *T. persius* are among the most closely allied of all our species of *Thanaos*, and the recognition of their specific diversity is due in the first instance to the skill of Mr. Lintner. *T. lucilius* differs from *persius* in size, being on an average considerably smaller, although individuals often approach each other in this respect; but most in the rather conspicuous cinereous patch enclosed between the vitreous spots of the fore wings,—scarcely more than indicated in *persius*—and in the lighter gray hue of the apical half of the same wing; the submarginal row of dark spots recedes less from the outer border on the lower half of the fore wing than in *persius*. Lintner says that this is true of the extra-mesial [his "submarginal"] band, but my specimens do not show this; neither is there any difference (except individual peculiarities) between the species in the comparative distance of the median vitreous spots from the outer margin.

Distribution (28:2). This butterfly is apparently almost confined to the Alleghanian fauna, where it is found from southern Canada to Maryland; it does not seem to have been taken any further inland, its westernmost localities being London, Ont. (Saunders) and Schoharie, N. Y., "not at all rare" (Lintner). It has not been taken north of the former place, nor south of Maryland (Weidemeyer, Mus. Mich. Univ.).

I have left the above statement as I wrote it many years ago, but since then it has been taken on the Yellowstone in Dakota, by Allen, and in Georgia, by Morrison, so that its range is vastly extended in both directions, though I have no memoranda of its capture in the intervening regions, where it doubtless occurs. This is the more probable, because of the slight attention that is given to the collection of species of *Thanaos*, and because of the wide distribution of the food plant of the caterpillar, *Aquilegia canadensis*, to which my friend, Dr. Goodale, has called my attention. This plant inhabits rocky woods, practically throughout the whole of eastern North America, south of Lat. 56° and east of the Rocky Mountains, though probably mostly confined in the southern states to elevated districts. The occurrence of the butterfly at the southern extremity of the Alleghanies and at the eastern edge of northern Rocky Mountains, makes it probable that it enjoys a similar range.*

In New England it is apparently confined to the southern half, never having been taken north of Massachusetts,† though here it has been captured on the top of the Holyoke range by several observers as well as in such elevated places as Amherst (Parker), Andover and Princeton (Scudder). It is also known from the vicinity of Boston, where it is common enough, Springfield (Emery), Cape Cod (Sanborn) and Wood's Holl (Scudder). The only New England localities are New Haven (Smith, Yale Coll. Mus.), New Britain (Scudder) and Guilford, Conn. (Smythe). Although found throughout most of the season, it is not so common as *T. persius*.

Oviposition. The eggs are generally, say in nineteen times out of twenty, laid on the under surface of the tenderer leaves of the food plant, but also sometimes on the stem or on the upper side of the leaves; they hatch in about ten days in June.

Food plants. The caterpillar seems to confine its attention to a single plant, the wild columbine, *Aquilegia canadensis* Linn., one of the Ranunculaceae, and no other species of *Thanaos* is known to feed on a plant anywhere near this. It was found on this by Saunders more than twenty years ago (Can. ent., i: 100) and he sent me a description of the larva in 1872 with sketches, of which I have made use. Since then, its transformations have been published by Lintner. Edwards, however, tells me that he has raised it in West Virginia on pig-weed, presumably *Chenopodium album*, a very different plant.

* If found in the Rocky Mountains, it will be interesting to learn if it feeds on *A. formosa*.

† I have, however, found a sure sign of its presence at Plymouth, N. H., in its nests.

Habits of the caterpillar. The caterpillar is a long while in eating its way out of the egg, doing this in the most deliberate manner, twenty-four hours being not uncommonly taken for this alone (86:28-30). Mr. Lintner gives the following account of the habits of the caterpillar (Ent. contr., ii : 60-61) :—

A large number of larvae of *Nisoniades lucifus* were found resting concealed on the under surface of leaves of *Aquilegia canadensis*, growing abundantly in an elevated, rocky locality in Bethlehem. Their shelter, as observed in numerous specimens collected at this time and in larvae subsequently taken, is constructed in a very ingenious manner. Shortly after the larva leaves its shell, and with its first feeding, it commences to cut a narrow channel in the leaf from the margin inwardly a short distance; this completed, from another point on the margin not far removed from the first, a second channel is cut, curving toward the former, the two not uniting but frequently running parallel for a short space. The portion thus nearly separated retains its connection with the leaf by only a pedicel-like attachment. Its own weight carries it downward to nearly the position which it is to assume, when a very slight effort by the young larva serves to bring it to its desired place, almost in contact with the lower side of the leaf, to which it is then fastened by threads passing between the two surfaces at several points. Sometimes, as if with the object of economizing time or labor, the lobe of a leaf is selected of which to construct this shelter, when but a moderate amount of cutting at its base gives the requisite size and desired form.

Resting upon the inside of this recurved portion, the larva may always be found, except during the brief time that it leaves its concealment to take its food from some neighboring leaf. Its rapid feeding soon satisfies its appetite, when it moves quickly back and resumes its position. In localities where the larva occurs, these hiding places may be readily found by bending over the stems of the *Aquilegia*, when these little bits of the bright green upper surface of the leaf, in marked contrast with the grayish green of the lower side upon which they rest, at once disclose their presence. Should one of them be found deserted, its former occupant may perhaps be discovered on a leaf near by, within a larger retreat of similar construction. From the gradation of sizes observed, it is probable that following each moulting a new shelter is constructed, of a size sufficient to cover the larva during that stage of growth, until at the last larval moulting, when an entire leaf is simply folded over, or two or more leaves have to be brought together in order to afford the necessary concealment.

In the foregoing account Mr. Lintner assumes that the lobe of the leaf falls by its own weight, but this I have not found to be the case. After biting the channel to form the desired flap (82:10), the caterpillar passes numerous threads across the neck of the flap, evidently to pull the parts together; and when the bit does not bend, the caterpillar walks along the channel to see if all is bitten clear and poking its head into the crevice tries either to pry down the flap or to push it up by tugging at the opposite shore with its head; it also helps matters by further attacks at the channel to make the neck of the flap longer or narrower. By repeated exertions with the head, the inclination of the flap is decided; it is generally bent downward beneath the leaf, but sometimes reversed in the opposite sense and brought above the upper surface. The rest of the work is wholly accomplished by the spinning of tight threads along the hinge, which gradually draws the flap over to a right angle with the leaf;

and it is not until then that threads are attached to the edges of the flap and to the leaf, by continually shortening which the flap is brought over to its final position, which is quite parallel to and almost appressed against the leaf. The process is an exceedingly slow one; one caterpillar that I watched required three or four hours before it brought the flap to a right angle, and only then did it rest awhile from its labors to partake of food; after this point the work is of course easier and more rapid.

On leaving this abode to construct a new one it always bites away the strands which have kept the flap securely in place, which then parts a little more widely from the leaf and often regains a position at right angles to it.

At first, that is when very young, the caterpillar eats the edges of the leaf on which it rests in patches, and evidently returns to the same feeding spot more than once, as numerous eaten patches may be found separated only by shreds of half eaten leaf. Sometimes when full grown, a nest will be made from an entire leaf bent over upon itself so as to show only the under surface. After it is half grown, and perhaps before, it rests in its nest with its head and thoracic segments bent at a right angle to the body. When alarmed it opens its jaws very widely. Mr. Lintner found the caterpillars so abundant that he obtained about a hundred of them in an hour's search; and I have found as many as twenty eggs on a very partial examination of a single clump of columbine.

Pupation. In preparing for the winter the caterpillar closes up its nest more tightly so as to make it impossible to look within, and thus it will remain. I have not observed that any precaution is taken to secure its fragile nest from falling to the ground; and one which I carried through the winter, in a cold-storage warehouse, to get the chrysalis period of early spring, came out alive, indeed, but so shrivelled that its body was no broader than its head and yet, with the head, was not more than six mm. long. Some went into such winter quarters as early as July 5.

When it wishes to transform in summer, it quits the nest it has last lived in, cuts the strands as usual, setting the flap free and wanders in search of something more to its liking. This, however, is a nest on the same plant, constructed on precisely the same general principles, so that it is difficult to understand what reason it can have for it, and why it does not utilize its last nest. Within such a nest it spins a Y-shaped shroud for the support of the bulk of the future chrysalis; one which I measured had a stem 2.5 mm. long and branches 5.5 mm. long; and at the tail it weaves several sets of meshes in vertical planes, the innermost having for its basis a Y-shaped mass of equal stem and branches each about 1.75 mm. long; and into this mass the hooks of the cremaster are plunged. The chrysalis state of those I have reared, lasted from eleven to fifteen days in July and August, and five days before eclosion signs of the coming change appear; first the

eyes turn pink, the next day inky; two days later the wings have turned of an inky hue, and the last day the whole body. In Mr. Lintner's experience, the whole period in August was only six or seven days; and in the only instance yet known of experiment with a hibernating caterpillar, by Mr. Edwards, the chrysalis period in spring was between six and seven weeks.

Life history. There are three apparitions of this butterfly annually; for it is partly single, partly double, possibly partly triple, brooded, but always passes the winter in the larval condition. The first butterflies make their appearance early in May and continue into June, and occasionally into the first week of July. They lay their eggs at once and continue to do so in the first, rarely in the latter, half of June. The eggs are hatched in about ten days, and the earliest larvae are nearly full grown by the middle of June; the majority change to chrysalis in the latter half of June, and the first week in July; they pass nearly or quite a fortnight in this condition, and the earliest of the second brood of butterflies makes its advent about the middle of July, though the males sometimes appear as early as the 6th. It, however, happens that all full fed caterpillars of this date do not change at once to chrysalis, or perhaps even the major part of them; others remain immovable through the entire hot season, as well as often through the winter; thus of three specimens reared together, which closed up their cells in the first four days of July, one changed at once to chrysalis (July 3) and emerged July 14, the two others remained caterpillars in closed cells without feeding and without changing to chrysalis all through July and August; in September one of them changed to chrysalis, and emerged at the end of the month, the other was still a caterpillar on October 1 and so passed the winter. Mr. Saunders also reared, in September, an imago from a caterpillar of the first brood. To return, however, to our second brood. It continues on the wing until the middle of August, occasionally nearly to the end; eggs are laid all through July, and probably into August.

The third brood is plainly a mixed one, made up partly by direct and undelayed descent from the second brood (for Mr. Lintner has raised the butterflies directly after six and seven days in chrysalis) partly by descent from the lethargic caterpillars of the first brood (for, as stated above, one of my caterpillars which was full fed early in July changed to chrysalis in September, and gave the imago the same month). This brood appears about the middle of August, and continues to emerge through September. Eggs are laid in August and at least early in September; but whether any but the August caterpillars reach maturity before winter is not known, nor whether they perish if they do not become full grown. All hibernating caterpillars that we know of in the whole genus do all their eating before winter and eat nothing in the spring, but change early to chrysalis in their hibernacula; this was the case with one of this species raised by Mr. Edwards in West Virginia, which appeared as butter-

fly on May 3, after more than six weeks in chrysalis. As appears from the above, the spring brood is made up of the progeny of all the broods of the preceding year, and the July butterflies are the only ones which come solely from the progeny of the brood immediately preceding it.

The butterfly, even the male, is described by Mr. Lintner as fond of hovering over the blossoms of *Aquilegia*.

Parasites. It is not a little strange that with the considerable number of caterpillars Mr. Lintner and I have had, no parasite has yet been found attacking them; but I have reared the tiny *Trichogramma intermedium* (89: 8) from the egg.

Desiderata. The few instances in which this butterfly has been carried through its early stages present such an unusual variety that a great many more observations are needed to make the relations of the broods to each other perfectly clear. Why is there such diversity in the length of the pupal condition? is it in any way correlated with lethargy of the caterpillar? How large a proportion of the caterpillars of a given brood contribute to the second or third brood beyond? What is the fate of the late butterflies or of their progeny? It would appear as if the butterflies which come out or fly after the middle of September were a waste of nature. Do the caterpillars ever successfully hibernate before they are full fed? What is the relative abundance of the three broods of the butterfly? What are the natural conditions under which the caterpillars pass the winter? Can it be in nests made from the leaves of the food plant, such as they have dwelt in as caterpillars, when the whole plant falls to the ground before the winter? The characteristics of the flight and postures of the butterfly have not been described, and our knowledge of its distribution is manifestly very imperfect. Does the hind tibial pencil of hairs of the male distribute an appreciable odor, and if so, what is it like? Are there no larval parasites?

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| Pl. 28, fig. 2. Distribution in North America. | 86: 28-30. Egg showing progressive attack on the shell by the enclosed larva. | |
| 80: 8. <i>Trichogramma intermedium</i> , a parasite. | 46, 47. Dermal appendages of caterpillar at birth. | |
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| Pl. 66, fig. 14. Egg. | <i>Chrysalis.</i> | |
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| 77: 8. Front view of head, mature caterpillar; colored. | Pl. 9, fig. 4. Male, both surfaces. | |
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| 80: 31-35. Front views of head, stages I-V. | 47: 4. Scales of the male imago. | |

THANAOS PERSIUS.—Persius's dusky wing.

[Six-spotted banded skipper (Maynard).]

Nisoniades persius Scudd., Proc. Ent. Soc. Lond., iii: 170 (1863);—Scudd., Burg. Proc. Ent. Soc. Lond., xlii: 286-287, fig. 1, u, l, r (1870);—Pack., Can. ent., iii: 113 (1871);—Lintn., Ent. notes, i: 33, pl. 7, figs. 3-4 (1872);—French, Butt. east. U. S., 353-360 (1886).

Erynnis persius Scudd., Syst. rev. Am. butt., 51 (1872).

Thanaos persius Scudd., Butt., 300, fig. 94 (1881);—Fern., Butt. Me., 105-106 (1884);—Mayn., Butt. N. Engl., 54, pl. 7, figs. 77, 77a, (1886).

Nisoniades lucilius Mead., Can. ent., vii: 163 (1875).

Figured by Glover, Ill. N. A. Lep., pl. T, figs. 7, 13, 14ed.

All April's quick desire,
All June's possession, a most fearless earth
Drinking great ardors; and the rapturous birth
Of winged things.

DOWDEN.—An Autumn Song.

Imago (9: 1). Head covered above with dark, maroon-brown hairs often mingled to a considerable extent, and in front largely, with pale or hoary hairs; beneath, the hairs and scales are mostly ashen gray and a few pass along the hinder edge of the eye without making a conspicuous streak; curving tuft outside of antennae black. Palpi beneath gray by a nearly equal intermingling of dark brown, ashen brown and sometimes pale or hoary scales, the darker ones predominating toward the distal extremity and then becoming pale tipped, excepting above, where the palpus is therefore always darker than beneath; the outer surface is also covered rather abundantly with very long, black hairs, which project far outward; the terminal joint is nearly uniform, very dark brown. Antennae very dark, slightly purplish, brown, the extreme base of the stalk-joints slenderly and inconspicuously annulate with white above, touched with conspicuous, white, basal patches in front, and at the base of the antennae flecked with slightly longer, white scales; posteriorly, it is still more largely flecked, often so as to be wholly white, with apical, brownish annulations which become less distinct and sometimes obsolete toward the club, which it covers with a uniform white patch; inferior surface of latter naked and dingy castaneous, becoming brighter and more reddish toward the white patch and toward the tip which is wholly castaneous. Tongue luteous at the extreme tip, luteo-fuscous near the tip and at extreme base, but blackish throughout most of its extent.

Thorax covered above with dark maroon brown hairs; beneath with purplish brown, mingled with slate brown, often pale-tipped hairs; legs dark brown tinged strongly with purplish on the femora and tibiae but with tufts of slate brown hairs beneath and on the same surface occasionally flecked with ashen scales; the joints of the tarsi not so dark and pale-tipped above, on the inferior surface toward the base and often on the whole of the inner surface hoary or ashen. Epiphysis of fore tibiae luteous, about four times as long as broad, densely clothed with short, microscopic hairs arranged in longitudinal rows, which are directed inward, converging toward the median carina. Spurs purplish, ashen or hoary on the surface next the leg and often toward the tip, the extreme tip reddish. Spines reddish luteous. Claws similar, sometimes even paler, but usually dusky, especially toward tip. Pad blackish.

Wings above soft, blackish brown, on the fore wings a little grayish, especially in the ♀, and marked with blackish bands. Fore wings with a large roundish spot in the upper half of the wing next the inner side of the intra-mesal band, often grayer or more cinereous than any other portion of the wing and sometimes accompanied by slight clouds of the same beneath, on the lower half of the wing. Basal half of the wing usually lightly flecked, excepting generally the costal border, with infrequent, exceedingly delicate white hairs; outer half rather uniformly and more abundantly

flecked with the same, and in a large measure replaced on the upper half of the wing and next the outer border of the lower half with slightly elongate white scales—all however, absent from the darker spots. There is occasionally a minute pale or vitreous dot in the cell, just beneath and generally a little outside of the base of the second superior subcostal nervule; very rarely (one ♂, out of more than forty) does it assume the size of the average of the other vitreous spots; these form a series as in most of the species, composed of two sets, a subcostal and median; the subcostal consists of three or four minute spots, the upper or the lower occasionally obsolete and all sometimes reduced to dots, situated in the succeeding interspaces below the second superior subcostal nervule and arranged in a usually straight line, directed from the costal border midway between the tip of the costal fold (in the ♂) and the tip of the wing, to the middle of the outer border. Vitreous spots are never present in the interspaces beyond the cell, and of the median set the lower is seldom present, and the upper usually reduced to a mere dot in the middle of the basal two-thirds of the upper median interspace; the spots are scarcely larger in the female than in the male. The basal half of the wing is almost entirely covered with black clouds, the exterior limitation of which is ill-defined, especially below, but is in general nearly parallel to the outer border, commencing above at the tip of the costal fold of the ♂; it is often traversed below by transverse, tremulous, zigzag, indistinct, cinereous threads, or faintly discernible clouds, or longitudinal grayish streaks or patches; it is very seldom that the outer portion of this basal field is more intense than the inner so as to give the effect of an intra-mesal band; the extra-mesal band is very inconspicuous, often noticeable only from the absence of the pale fleckings; it is nearly straight, bent or curved at the bottom of the subcostal area, of nearly equal width and includes next its inner edge the subcostal, and in the middle of its inner half the median, vitreous spots; it is composed of confluent, longitudinal bars, tapering and separate apically, forming thus an outer border of a succession of arrow heads, often followed in the lower half of the wing by dull cinereous patches; the submarginal series of spots is usually even less distinct than the extra-mesal band and consists of more or less roundish spots, receding slightly from the outer margin and usually becoming lunate in passing downward, often wholly or partially confluent into a moniliform band, generally followed outwardly by delicate, hoary deckings. The outer border is edged with black; the fringe is scarcely lighter than the ground color of the wing, sparsely overlaid on the basal half with whitish scales. *Hind wings* very nearly uniform, sometimes with a slight mulberry or warm brownish tinge with the least possible indication of any apical spots; when most distinct they form but faint, cloudy, scarcely paler, roundish spots, the marginal row least distinct and often wholly obsolete, the other sinuous in the upper half of the wing, parallel to the outer border in the lower half, placed in the middle of the outer two-thirds of the wing; outer margin edged, generally less distinctly than on the fore wing, with blackish. Fringe slightly paler brown than the ground color of the wing, a little paler still, apically, and the extreme tip often whitish.

Beneath dark, sometimes blackish fuliginous, with a very slight purplish tinge on the hind wings and the costal and outer border of the fore wings; other parts of the fore wings paling toward the inner margin, where it is pale cinereous or ochraceous, or even whitish. *Fore wings* with the vitreous spots of the upper surface exactly repeated beneath, and often the wing is without any other marking excepting at the extreme tip, which is lightly flecked with hoary; usually, however, there is a marginal series of minute, pale ochraceous spots, enlarging slightly beneath, sometimes reduced to short longitudinal lines in the middle of the interspaces; and these markings are generally accompanied by a slightly heavier and more extended gray flecking, as well as by a more or less distinct submarginal series of pale, cloudy, longitudinal streaks across the whole of the middle of the outer two-fifths of the wing; sometimes they are obsolete above or a faint cloud overspreads the whole of this region; outer margin narrowly edged with black; fringe dark, dusky brown, slightly paler at the extreme base, rarely overlaid on basal third with hoary scales upon the upper half of the wing. *Hind wings* with a double row of very faint pale ochraceous spots, one marginal,

generally the more distinct, and usually reduced to very short longitudinal lines, the other more cloudy, consisting of a slightly sinuous series of small, roundish spots in the middle of the outer two-fifths, occasionally the outer half, of the wing; very rarely one can see very faint, larger, dusky spots on either side of the extra-mesal series; outer border and fringe as in the fore wing.

Abdomen above blackish, the tips of the segments edged minutely with dark gray; beneath more or less heavily flecked with grayish brown. The abdomen of the female ends in a very bluntly rounded tip, a very little broader than long, and is furnished with very short scales; when denuded, it is seen to be also clothed with very frequent hairs. The appendages of the male (36:1-3) have the centrum of the *upper organ* short, slender, high. Hooks very long and slender, tapering, slightly compressed, separate at base, tuberculate (with one tubercle) externally next the base, basal halves divaricate, but beyond subparallel, curving inequally, the tip hooked downward, tapering rapidly and sharply pointed; from the middle of the ridge which unites their bases, a very minute denticle depends with a projecting bristle. Lateral arms broad at their origin, made one-half as small below by an excision of the posterior edge, directed downward and slightly forward, then bent at about a right angle backward, and very soon expanded to a common, very large, spatulate cup, opening upward, its outer half composing the inferior armature of delicate points, widely separate from the base of the terminal hooks. *Left clasp*: Main body nearly triangular, the apex at the point of attachment, widening rapidly, a little curved longitudinally and slightly gibbous laterally. Blade very long and slender, the basal fourth rapidly narrowing, beyond nearly equal, depressed, curving inward, at first slightly, afterwards rapidly, so as to be sub-falcate; otherwise nearly straight; tip produced to a sharp point; basal process consisting of a gibbous, subreniform lobe, not half so long as the blade, constricted at the base, having a general backward direction, curved a little inward, its upper margin strongly arched, its lower excised, rounded at the tip, the basal portion of its lower margin bent inwards and forming a slight, sharp, inconspicuous ridge. Lobe large, broad, uniform in width, as long as the basal process of the blade and twice as broad, directed backward, somewhat upward and a little inward, its outer surface turned slightly upward, its apex rounded and curved slightly inward. *Right clasp*: Main body much as in the opposite clasp, but having a broad angle near the middle of the upper margin, beyond which it does not broaden; it is also more deeply excised on the lower margin. Blade as long as that of the left clasp, narrowed at the base and beyond depressed as there, but just beyond the middle it is bent slightly downward, and has its upper margin slightly angulated, or is at least curved a little downward in the outer half; close to the tip the inner edge is angulated again, broadening the tip, which terminates in a rounded right angle; basal process consisting only of a small, triangular, rounded, backward prolongation at the extreme base of the upper edge of the blade. Lobe extremely broad and large, half as long as the blade, angulated in the middle of its lower margin, its upper half produced as a narrowing rounded plate, curved strongly over upon itself, the concealed margins armed with a few rather prominent spinules.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 10 mm.						
Length of fore wing.....	14.	16.	18.25	16.	17.	17.75
antennae.....	6.7	8.	8.4		8.	8.4
hind tibiae and tarsi..	4.6	6.45	7.5	4.4	7.	7.25
fore tibiae and tarsi..	4.	4.5	4.8	4.	4.5	4.4

Described from 443, 67.

Accessory sexual peculiarities. The costal fold of the fore wing of the male encloses a mass of clustered pediform bristles (47:3 a) about .75 mm. in length; scaphiform androconia (3 b, c) of varying lengths rarely so little as twice as long as broad, found on the costal vein; and stout, rod-like androconia (3 c, d) of varying length,

simple, or two-pronged, the cover-scales (3 f) always rounded but of very varying shapes.

Egg (66: 11). Usually furnished with eleven or twelve, sometimes with as many as fourteen, rarely with as few as ten, vertical ribs, running in a nearly straight course from the base to the edge of the summit, there or above united so that only a few more than half the number border the micropyllic depression; they increase very slightly and gradually in size from the base to the shoulder of the egg, where they are much elevated and slightly overarch the micropyllic depression; the space between the ribs is traversed by cross lines of which there are about twenty-five between the base and the shoulder of the egg; they are very delicate and equal, slightly further apart above than on the sides of the egg; where they traverse the ribs they slightly thicken the latter, giving them a beaded appearance; the micropyllic depression (69: 1) is scarcely wider than the greatest width between the vertical ribs. Color of egg pale yellowish green, the ribs, especially where the cross lines strike them, being brownish or golden brown; changing in about two days, first to a pale, afterwards to a deeper, salmon color which later becomes blood red or claret red, the vertical ribs showing a dark golden amber. Width of egg, .84 mm.

The egg differs decidedly from that of *P. lucillus* in the considerably greater elevation of vertical ribs at the shoulder and in that those which are continuous throughout are mostly straight from bottom to top.

Caterpillar. First stage. Head (80: 37) orbicular, very slightly cordiform, scarcely broader than the middle of body, piceous, minutely granulate with scattered, short, stout, white or colorless hairs; mouth parts dark castaneous. Body very pale green with a slightly brownish yellow tinge. Legs and prolegs concolorous, the claws of the former pale testaceous; the skin delicately and rather sparsely punctate. Length at birth, 2.5 mm.; when full grown, 3 mm.; breadth at birth, .3 mm.; when full grown .7 mm.

Second stage. Head (80: 38) black, with a dull luteous tinge in front, subquadrate with angularly emarginate summit, full rounded sides, rather profusely covered with minute granules, giving rise each to a short, white hair, next the neck shining luteous; mouth parts color of head; antennae and ocelli piceous. Body pale yellowish green, profusely dotted with pale warts, each giving rise to a short, fungiform hair of same color; these warts are more or less definitely arranged but only along the lateral line form a series so close as to give the effect of a pale stripe, about five dots being here found on each segment in a row. Prothoracic shield of the color of rest of body. Legs and prolegs color of body, the claws of former scarcely infuscated. Spiracles pale luteous, very inconspicuous. Length, 4 mm.

Fourth stage. Head (80: 39) black, sometimes obscurely mottled with ferruginous brown, with fine, short, inconspicuous, white hairs. Body pale green, sprinkled profusely with raised, white dots from each of which springs a very short, white bristle which, at least on the sides, is short, wine-glass shaped; a slender, darker green, mediodorsal line and slender but variable, pale yellowish white, lateral lines; spiracles legs and prolegs concolorous. Length of body, 8.5 mm.; breadth, 1.4 mm.

Last stage (77: 7, 15). Head (80: 40) mostly ferruginous brown with pale, inconspicuous, vertical streaks through it; or, the triangle and broad, ovate patches on either side occupying most of the face are ferruginous brown and are separated by dark or blackish streaks; but at other times it is pale yellowish brown with vertical, broad stripes in which the tubercles are darker or very dull ferruginous. In the middle of the summit and extending a little way down the front; the back of the head and the lower parts of the sides black or blackish. Or, again, the whole head may be piceous with ferruginous or luteo-ferruginous, small spots and narrow stripes; in particular the triangle may be enlivened with this color both below and above, and in the centre of each hemisphere, while slightly converging vertical streaks between the central spots and the median suture fall from the summit of each hemisphere; so also a dot of the same color may be found on either side a little beyond the base of the triangle and the epistoma may be more or less tinged with it; sutures rather broadly and obscurely

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dusky; hairs white, labrum and base of antennae and whole base of labium pale. Body much as in the previous stage but with more of a hoary tinge to it, the white dots becoming larger and more abundant, bearing simple, short, tapering hairs. Spiracles straw color; legs pale yellowish green tipped with fuscous; prolegs concolorous with the under surface of the body. Length, 28 mm.; breadth of head, 3.25 mm.

Chrysalis (85:34). Head, thorax and appendages dull but glistening olivaceous green, the head and, excepting the eyes, its appendages, the legs, the prothorax, and the posterior borders of the wings more or less infuscated. Front of the head almost blackish; the stigmatal guards of the thorax are velvety black. Head and prothorax rugulose, on the latter with a distinct, transverse trend. Abdomen pinkish brown, faintly mottled with pale dots and with the posterior margin slightly infuscated; the last two segments tinged beneath with olivaceous. Cremaster strongly infuscated, the hooklets castaneous. Spiracles pallid with a slightly fuscous areola. Whole body, excepting the wings, but especially the anterior half, with very short, pale, tapering, sparsely scattered hairs, which become darker on the front of the head. Length of body, 13.5 mm.

Geographical distribution (20:1). The distribution of this butterfly, as far as we know it and as represented on the map, is somewhat peculiar, and evidently will be considerably modified when our information is increased. Along the Atlantic sea-board it occurs throughout the Carolinian and Alleghanian faunas. It is a common species in the north, but probably becomes rarer further south. With the exception of a single locality, Dallas, Tex. (Boll); it is not known west of the Atlantic sea-board in the southern part of the United States, but in the northern part, where it reaches nearly or quite to our northern borders, it extends across the entire continent; it is found through our entire Pacific coast, where it is either recorded or I have seen specimens from San Diego and Arizona, through central California and the Sierra Nevada (H. Edwards) to Washington Territory at Yakoma River (Lintner). In the western half of its range the northernmost point at which it has been found is the last mentioned, together with Montana and Dakota (Morrison), Lake of the Woods (Dawson) and Wisconsin (Hoy). It has also been taken in the interior from New Mexico (Edwards) and Arizona through Colorado, common (Packard, Snow and Mead) to the Yellowstone (Allen). East of this its latitudinal range is at once diminished so far as we have any information: it occurs in Wisconsin, common (Hoy) and northern Illinois (Worthington). Along the Atlantic sea-board, however, it occurs south as far as Okahumpka (Maynard) and other parts of Florida (Norton), but it is not noted, curiously, by Abbot, though it was sent me from South Carolina by Atkinson, and from West Virginia by Edwards. The northernmost localities along the Atlantic sea-board at which it has been reported are Ha-ha Bay on the Saguenay (Saunders, omitted on the map), southern Ontario, taken occasionally but not very common (Saunders), Toronto and Ottawa (Fletcher) and Albany, N. Y., abundant (Lintner).

In New England it is everywhere pretty common from the valleys of the White Mountains (Scudder), Norway (Smith) and Mooshead Lake, Me.

(Scudder), to Cape Cod (Fish) and Nantucket, Mass. (Scudder) and New Haven (Smith, Yale College Museum) and Norwich, Conn. (Scudder).

Oviposition. The eggs are laid singly on the upper surface of leaves, the young and tender terminal leaves being nearly always chosen and the egg deposited near the middle of one side, invariably away from the edge; in one instance I found an egg laid on the young shoot itself. Young trees also, and especially suckers, are preferred. The eggs hatch in about a week, but I have neglected to note just how long in several instances in which I have obtained them.

Food plants. The only food plants known to me belong to Salicaceae. I have found it in the greatest abundance on *Salix humilis* and *Populus balsamifera*, once on *P. tremuloides* and often on *P. grandidentata*. Lespedeza was given by me some years ago on the mistaken determination of one of Harris's descriptions of caterpillars. It was presumably this species found by Mead on willow (Can. ent., vii: 163), but I am not aware that others have mentioned it, on this or any other plant.

Habits of the caterpillar. On emerging, the caterpillar eats only the crown of the egg, generally leaving the harder ribs sticking up as points, and at once quits the leaf and seeks another; at least this is generally the case when it finds itself on willow; on poplar it appears to be less particular. Here it at once constructs a nest, usually, in this its first stage, by folding a cut flap of the leaf over upon the under side, later invariably upon the upper side (82:7). The caterpillar seems to wish to live near the middle of the leaf, for the flap is, in the first instance, generally bitten out of the very middle of the leaf, near the midrib, including no part of the edge, and is usually of a very short, tolerably regular, oval shape, not more than 5 mm. in diameter; subsequently one of double that diameter is made, bent over upon the upper surface of the leaf so as to cover a spot near the midrib, and attached by pretty long and distant shrouds to the surface of the leaf and the midrib. It is made by biting a narrow, curved or bent channel inward from the edge of the leaf. Here it takes up its abode back downward and rarely if ever ventures from home, except under cover of the darkness; of the hundreds that I have collected, I do not recall seeing one out of its nest during daylight. In its first larval stage, the caterpillar eats the surface of the leaf only, whether of the upper or under side, at least in confinement, and in the case of *P. grandidentata* leaving untouched even the finest harder parts of the reticulation.

When half grown its mode of eating is peculiar, and a ready means of detecting the presence of the caterpillar when its nest is beneath the leaf; it eats irregular little holes upon either side of its nest, always preferring the under surface and leaving the nest intact, and these are scattered over the leaf making it look as if it had received a charge of small shot or rather of an-

gular pebbles; the holes sometimes become irregular, ragged slits. Part of these notes are taken from observations made in 1861. It is a slow grower; it remains about ten days in its first stage and it is six or seven weeks after hatching before the last moult is passed. After it has become half grown, and I believe earlier still, it always rests in its nest with its head bent at right angles to its body.

Life history. This butterfly appears on warm, sunny hillsides early in May, usually during the first week. Mr. Hambly once took it on April 30th at Middleboro, Mass. According to Mr. Lintner's observations, the female does not make its appearance until about ten days after the male, and both are always abundant in Albany, N. Y., the male sometimes worn, by the third week of May. Fresh specimens continue to appear until nearly the end of the month, and the insect remains upon the wing, even in the southernmost parts of New England, until at least the middle of June, and, further north, much later; for in the third week of this month good specimens are common in the White Mountains, and I have taken several specimens on the last day of the month at Williamstown, Mass. It appears also at just about the same season in central California and also in Colorado, for to judge from dated specimens examined, specimens are most abundant in the early half of June and after that are rubbed.

The eggs of this brood appear to be rarely laid before the end of the first week of June, but by the 15th they are found in abundance, and the young caterpillars begin to appear; eggs may still be found until the very end of June, and thereafter throughout the season the caterpillars. These, as I have said, are very slow growers, but it appears probable that some of the earliest may go forward with relative rapidity to chrysalis and imago the same year, for there are some scant records of a second brood; thus Sprague reports several fresh specimens captured in the vicinity of Boston between July 18 and 27; I have myself seen (but not taken) what I judged to be the same in a fresh condition at Waltham, August 3d, and in the same place a very rubbed specimen probably to be referred to this species on August 26; and I have seen poor specimens from Colorado (perhaps fresh when captured), taken by Packard July 8 and from the Yellowstone, July 18.

But if this second brood exists, it must be as an exceptional thing, for I have carried the earliest caterpillars I could find—and they are very easily discovered—through the summer under the favorable conditions of the house and never found any sign of acceleration; on the contrary all alike reached their final moult during July. It was not until July 17 that the fattest had become full grown and closed its nest for the winter; the next did not do so until August 1; the others during this month, mostly before the 20th, the last by September 1. Here they remained, promptly sealing up every opening my curiosity made until nearly the middle of October,

when they were placed for the winter in a cold-storage chamber and not released until May 10. All were found still caterpillars and still active. As before, they resisted all attempts at inspection, so that I can only say that half of them were chrysalids, half larvae, on May 27 and that the first one emerged from the chrysalis on June 13, just at its proper season, after at least sixteen days in the chrysalis.

Habits of the butterfly. The butterfly is fond of alighting on wet sand and may most frequently be found by shady roadsides near woods, seeming to frequent the vicinity of hazel. It is fond of flowers and Dr. Asa Gray once showed me a specimen having the pollinia of *Platanthera hookeri* attached one to each of its eyes—the only naked parts of the body where they would stick, unless it were the tongue. It flies with a strong, rapid movement especially when disturbed and seldom passes from one spot to an adjacent one without describing several irregular, rapid circles; at such a time it rarely rises more than two or three inches above the ground; just before alighting, the wings have a quivering motion. It is an uneasy insect, difficult to suit; no sooner alighted on a choice bit of moist, shady ground than off it starts again, and, in alarm, shows the greatest uneasiness.

It usually rests on the ground with the wings fully expanded, touching the earth behind but considerably elevated in front; when sipping the moisture from the surface, the antennae droop at an angle of about 30° with the body. When it alights on a twig, the wings are generally placed at about right angles with each other and the antennae then diverge an angle of about 110° ; but its wings are soon fully expanded, as on the ground, and then the antennae approach until at about right angles with each other. One may sometimes see them alight with expanded wings in the bright sun, and then as if it were too hot for them, raise all of them equally till they are edgewise to the sun or with the slightest possible divergence, the fore wings dropped a little so that the costal margin is entirely vertical.

Parasites. One of the caterpillars which I carried through the winter in a cold-storage warehouse and which actively closed every opening to its nest as fast as one was opened, finally succumbed to a hymenopterous parasite which had been preying upon its vitals during all these vexatious proceedings. On June 20, after hibernation, I discovered within the nest a pale, greenish yellow maggot which had just left the side of the caterpillar and was squirming about. It was about 7 mm. long; three days later it had changed to a pale lemon yellow pupa and was lying in a curved position in the box in which I had placed it; later it escaped and so could not be determined; it was in the pupa state ten days or less.

Desiderata. Our knowledge of the distribution of this insect in the interior of the continent is very inadequate, as the statistics given readily show. The most perplexing thing about its life history is the apparent occasional appearance of a second brood in the north; we know nothing

about the broods at the south and perhaps when known they will throw light upon this point; whether north or south further experiments with rearing the insect are likely to shed most light upon all the obscure points in its history. Does the pencil of hairs on the hind tibiae of the male distribute any odor from the coxal gland, and if so of what nature? What is the parasite whose presence is known, and are there others?

LIST OF ILLUSTRATIONS.—*THANAOS PERSIUS*.

<i>Egg.</i>	<i>Chrysalis.</i>
Pl. 66, fig. 11. Egg, colored.	Pl. 85, fig. 34. Chrysalis.
69: 1. Micropyle.	<i>Imago.</i>
<i>Caterpillar.</i>	Pl. 9, fig. 1. Male, both surfaces.
Pl. 77, fig. 7, 15. Mature caterpillars, dorsal view.	36: 1-3. Male abdominal appendages.
80: 37-41. Front view of head, stages i-v.	47: 3. Scales of the male imago.
82: 7. Nest.	<i>General.</i>
	Pl. 28, fig. 1. Distribution in North America.

GROUP II (*juvenalis*).

Antennal club composed of twenty-one or more joints; fore wings with subapical vitreous spots; hind coxae and tibiae with no special apurtenances; costal fold of fore wings of male with pediform bristles; upper organ of male abdominal appendages with an elevated prickly crest; terminal hooks separate, stout; tooth stout; clasp with broad elongated, straight blades, especially on the right side, the left clasp with separated basal and median processes, the median always armed. Eggs with sixteen vertical ribs. Larval food Leguminosae and Cupuliferae. Two broods annually in the northern United States.

SPECIES: *juvenalis*, *horatius*, *terentius*.

***THANAOS JUVENALIS*.—Juvenal's dusky-wing.**

[Juvenal's skipper (Harris); seven spotted banded skipper (Maynard).]

<i>Hesperia juvenalis</i> Fabr., Ent. syst., iii: 340 (1798);—God., Encycl. méth., ix: 727, 728 (1819).	364 (1886);—Mayn., Butt. N. E., 56, pl. 7, figs. 82, 82 a (1886).
<i>Papilio juvenalis</i> Smith-Abb., Lep. ins. Ga., i: 41-42, tab. 21 (1797) (not fig. sup.).	<i>Erynnis juvenalis</i> Scudd., Syst. rev. Amer. butt., 51 (1872).
<i>Nisoniades juvenalis</i> Westw.-Hew., Gen. diurn. Lep., ii: 519 (1852);—Morr., Syn. Lep. N. A., 114 (1862);—Scudd.-Burg., Proc. Bost. soc. nat. hist., xlii: 297-298, fig. 10u, ub, l, r (1870);—Park., Can. ent., iii: 113 (1871);—Linton, Ent. contr., iv: 66 (1878);—French, Rep. ins. Ill., vii: 102 (1879).	<i>Nisoniades juvenis</i> Hübn., Verz. schmettl., 108 (1816).
<i>Thanaos juvenalis</i> Harr., Ins. inj. veg., 3d ed., 300 (1862);—French, Butt. east. U. S., 263-	<i>Nisoniades costalis</i> Westw.-Hew., Gen. diurn. Lep., ii: 519, pl. 79, fig. 8 (1852).
	<i>Nisoniades ennius</i> Scudd.-Burg., Proc. Bost. soc. nat. hist., xlii: 296-297, fig. 9u, ub, l, lb, r, rh (1870);—Park., Can. ent., iii: 118 (1871).
	Figured by Glover, Ill. N. A. Lep., pl. 2, fig. 2; pl. 34, figs. 2, 3?; pl. B, figs. 14, 15; pl. H, fig. 57, ined.

From flower to flower the boy it led,
He still pursued the pretty thing.
Away it sprang from bed to bed,
Now sipping dew, now on the wing.
And to the fields it took its flight:
He thought the prize was worth the chase,
O'er hedge and ditch, with all his might,
He followed up the pleasing race.

TAYLOR.—*The Morning's Task*.

A most acute juvenal; volable and free of grace!

SHAKESPEARE.—*Love's Labour's Lost*.

Imago (♂: 13, 14). Head covered with darker and paler gray brown hairs; the eye encircled narrowly behind with pale gray brown scales, becoming whitish in a slight

patch behind the black tuft outside of the antennae. Palpi gray, from a nearly equal mingling of dirty white and brown scales, the latter longer and often more abundant than the other, especially toward the tip, and accompanied by blackish hairs, which are more frequent along the outer anterior edge; the palpi are always darker above than beneath, and the terminal joint darkest of all and uniform, seldom with any intermingling of pale scales. Antennae very dark brown, sometimes almost black, with a slight purplish gloss, the tips of the joints on the apical half of the stalk with faint and narrow pale annulations above, distinct, white and broader below, especially anteriorly, and extending over the whole stalk; posteriorly the annulations are a little duller, are tinged with nacreous, which extends over most of each joint, increasingly so toward the club, and there forms a continuous, very pale buff or silvery white streak; club beneath naked and dark castaneous next the white portion, but elsewhere obfuscated, often blackish. Tongue blackish fuscous, becoming luteous at tip.

Thorax covered with nearly uniform dark brown scales, below slightly paler than above, and occasionally tinged with purplish. Legs gray brown, flecked with paler scales beneath and within, even on the tarsi; the tibiae, especially the longer pairs, darker above and tinged with purple; under surface of tarsi naked and reddish luteous. Spurs gray brown, the apex reddish, black-tipped; spines reddish luteous; claws dull reddish at base, dusky on apical half; pad blackish.

Above *fore wings* dark grayish brown, tending to pale gray brown, especially in the ♀, which is always paler than the male, and in a lesser degree to the outer half of the wing of the ♂. The whole wing in both sexes pretty uniformly and sparsely flecked with whitish or very pale lilaceous, elongated scales and hairs, which give it a slightly hoary appearance; they are more abundant on the apical than the basal half of the wing, and are absent from the dark spots of the wing, but sometimes accentuate these by clustering around their edges. The wing is marked with blackish, blackish brown, and dark brown and vitreo-silvery spots. The last are composed of a single spot in the cell and a transverse series in the middle of the outer half of the wing; the cellular spot is round, usually of about the same size as the average of the others, seldom larger and often reduced to a mere dot or a transverse streak; it is situated in the upper half of the cell, between the bases of the first and second superior subcostal nervules, and is accompanied, very rarely in the ♂, usually in the ♀, by a similar smaller spot in the lower half of the cell, sometimes only semi-vitreous; the series in the outer half of the wing, the spots of which are almost invariably larger in the ♀ than in the ♂, and only half of which are constant, consists: first, of an upper series of four quadrate, usually elongate spots, one in each succeeding interspace below the second superior subcostal nervule, the uppermost occasionally reduced to a dot or even, very rarely, obsolete, the next, usually the longest, extending outward beyond the others, the lowest almost always square,—the whole depending at about a right angle from the middle of the outer two-fifths of the costal margin; second, of another series of four spots, half in the median, half in the medio-submedian interspaces, both of the latter almost always obsolete in the ♂, the lower of them often absent in the ♀; when all are present, they form a slightly curving row, opening outward, the lower three in a nearly straight series parallel to the outer border, the outer border of the lowest spot striking the middle of the outer half of the submedian nervure, the outer limit of the uppermost spot in the centre of its interspace; the lower of the median spots is very rarely obsolete and only in the ♂; these spots are usually triangular and nearly equiangular, the apex outward, or, especially in the ♀, are subnate, and in both sexes are seldom smaller than the subcostal series. In the ♀ the lower and occasionally the upper of the two interspaces which intervene between these two series of spots is occupied by a small spot or dot, never approaching the others in size, and which connects the two sets into an arcuate series. The basal half of the wing is filled with many not very large, inconspicuous, dark, cloudy, only occasionally blackish spots; they most frequently occur along an intra-mesal line from the cellular spot—which is often edged with blackish, especially on the inner side—to the middle of the basal two-thirds of the submedian nervure, and also midway between this and the

base, especially in the cell; but they are wholly irregular and fleeting, although occasionally, especially in rubbed specimens and in the ♀ rather conspicuous. The outer half of the wing is traversed by two series of dark spots: one is a transverse, gently arcuate band, subparallel to the outer border, and, in the middle of the outer half of the wing, composed of nearly or quite connected longitudinal dashes, always broadest toward the inner side and often elongate triangular; in the upper half of the wing the vitreous spots lie within this band at its interior border; in the lower half they lie nearly or quite in its middle, the dark spots often, and especially in the ♀, reduced to a mere edging of these; when the vitreous spots of the medio-submedian interspace are absent, their place is often supplied by a grayish centre to the dark spots; more frequently than the others, the dark spots of the lower median and medio-submedian interspaces are bordered externally by a lunulate flecking of grayish or hoary scales; the other and outer series consists of a subequal, submarginal set of dusky brown spots, a little larger and slightly further removed from the outer border below than above, generally roundish in the upper, lunulate in the lower half of the wing, and often tipped outwardly by pale dots or more than usually intense gray flecking; outer margin narrowly edged with blackish; fringe gray brown, scarcely paler than the wing, but flecked to a greater or less extent on the basal half with white scales. *Hind wings* soft, cloudy, blackish brown, generally duller and paler in the ♀ than in the ♂, furnished abundantly on the lower half with long, silky hairs of the same color; the outer border is furnished with a double series of confused, cloudy, pale gray or dull yellowish brown, roundish spots, one marginal and regular, the other submarginal and sinuous, each followed interiorly by similar indistinct and confused spots, slightly darker than the ground color; the whole a repetition of the marks below, and almost always very indistinct in the ♂, sometimes in the ♀; outer margin rather narrowly edged with blackish; fringe paler than in the fore wings, being tinged with yellowish and often dirty white on the apical half; the base is often partially overlaid with blackish or dusky scales, but by no hoary ones.

Beneath rather dark purplish brown, the fore wings more or less grayish. *Fore wings* with the vitreous spots scarcely larger than above, occasionally accompanied, especially in the female, by similar spots in the medio-submedian interspace; they are, however, no more frequently present in the interspaces beyond the cell than they are above; the extra-mesal spots are edged within and without with blackish brown clouds presenting together the semblance of a band; beyond, the submarginal, dusky, cloudy spots are scarcely so distinct as above, often smaller, accompanied within by a parallel series of similar, but generally smaller, pale spots and without by more distinct paler, smaller spots, often sagittate, each intensified in the middle to form a longitudinal whitish line conducting to the outer border; the apex of the wing, beyond the submarginal vitreous spots, is flecked with hoary scales, often obliterating the markings; outer border edged narrowly with blackish; fringe of the ground color of wing, a little paler at extreme tip and on the basal third overlaid with hoary scales. *Hind wings* with a marginal series of very dull ochraceous, indistinct, small, marginal spots in the interspaces, often more intense along a median longitudinal line, followed by large, cloudy, dusky, often scarcely discernible, spots in the same interspaces; these again by spots similar to the submarginal ones, but often sagittate, and generally obsolescent excepting in the median interspaces, where the upper one occupies the middle of the interspace; these three rows of spots extend from the costal to the submedian nervures, but the last is irregular, receding far from the outer border in the interspaces beyond the cell, and they are followed by dusky spots similar to those which succeed the marginal row but often still fainter, excepting in the costo-subcostal and upper subcostal interspaces, where they are more distinct and generally have a large, pale or ochraceous pupil of a quadrate or triangular shape, thus forming usually very distinct spots; the lower is situated in the middle of the basal two-thirds of the upper subcostal interspace; the upper in the middle of the costo-subcostal interspace; in the middle of the cell, just within a line connecting the bases of the first subcostal and second median nervures is a small, pale ochraceous spot, often obsolete; outer margin and fringe as in fore wing, excepting that the latter is overlaid at the base by pale ochraceous instead of hoary scales.

Abdomen above blackish brown, the tips of the segments paler; beneath, ochraceous brown. Terminal segment of male covered with a row of very long scales, arched or semicircular when viewed posteriorly; sides greatly expanded and clothed with much shorter hairs; clasp covered with very long hairs nearly to their tip and extending as far back as the uppermost scales; all the scales of the body color, a dark mouse brown. When denuded, the terminal segment is seen to be projected over the aperture, forming a rounded lobe almost entirely concealing the upper organ. Upper organ (36: 24-27, 34, 35) having the centrum rather long and not high, nor greatly curved; posterior part of upper surface elevated, and bearing, near the extremity, a crest in the form of an appressed plate, facing backward and very slightly upward, narrow at base, rapidly and greatly expanding above, the outer angles sharp, the upper border broadly arched, and bearing an extensive armature of slender clustered spinules, curving forward; anterior to it the upper surface has a distinct median furrow. Hooks short and stout, compressed, bluntly pointed, divaricate, pretty widely distant at base, and bearing at their junction a pretty broad, very short and small, bilobed, appressed tooth. Lateral arms of nearly uniform size, curving in all their course, having at first a general downward direction, then bent in a sharp angular curve, at less than a right angle, beyond which the limb is directed upward, backward and inward, and bears at the united tips the inferior armature, which is a very large and broad belt of raised points. The crest and arms are somewhat asymmetrical. *Left clasp*: Main body pretty broad, irregularly gibbous, increasing rapidly in width from the base backward, the terminal edge squarely docked between the lobe and blade. Blade very long and slender, the outer surface facing upward and outward, curving slightly inward and upward, the upper edge with a median, broad, slight denticle, the apex rounded, its inner angle produced to a sharp point, bent inward and a little downward, armed with minute, spinules; basal process subtriangular, attached by a narrow neck, one apex, with the smaller half, directed backward, its tip pointed and bent a little inward; the other apex, with the larger half, directed upward and a little forward, bent also strongly inward, and at the same time twisted so as to make the outer surface face a little backward; this part of the surface is armed with minute spinules and the tip is rounded. Lobe widely distant from the basal process of blade, quadrate in shape, nearly twice as broad as long, a little broadest at apex, directed backward and a little upward, curved also somewhat inward and a little downward, the lower portion of apex a little produced, rather laterally than apically, but rounded. *Right clasp*: Main body not broad, nearly equal, the upper portion of the base largely docked diagonally. Blade long and broad, directed somewhat upward, curved, especially near apex, a little inward, the outer surface twisted a very little upward; it is broadest in the middle and tapers beyond very gradually to a well rounded tip; basal process wanting. Lobe closely contiguous, and at base parallel to the blade, long and slender, directed a little upward, curved inward; the apical half tapers suddenly to a long and very slender, nearly equal, curving dactyl, directed a little downward and nearly straight inward, bluntly pointed and armed at the apex with some very minute spinules.

Measurements in millimetres. Length of tongue, 9.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	19.5	20.	22.5	18.	21.	21.5
antennae.....	9.5	9.75	11.	8.75	9.8	10.5
hind tibiae and tarsi.....	7.85	7.85	9.	6.25	7.9	9.
fore tibiae and tarsi.....	4.95	5.2	5.75	4.5	5.25	5.25

Described from 58 ♂, 2 ♀.

Accessory sexual peculiarities. The costal fold of the fore wing of the male (43: 12) encloses a clustered mass of pediform bristles (47: 5 e) about 1 mm. long; scaphiform androconia and others of varying shapes (5 a, b) seated on the costal vein; stout, simple, or rarely two-pronged, arcuate bristles; and large, broadly rounded cover-scales (5 c, d) varying somewhat in size and shape.

Egg. A little higher than broad, broadly rounded at base, so as to be broadest just above the base, narrowing regularly nearly to the tip and broadly arched, a little flattened above; sides furnished with sixteen ribs of which only six reach the micropyle, most of them stopping abruptly at the rim of the summit; they are compressed and not high excepting above, where they are fully twice as high as below; space between the ribs filled with straight and nearly equidistant raised cross lines about .033 mm. apart. The ribs are about .14 mm. apart and when two of them unite it is very abruptly, the two ribs bending toward each other so as to meet at right angles; floor of cells very delicately punctate; ribs at highest about .04 mm. high; the highest point of the ribs is distant about .2 mm. from the edge of the micropyle. The micropyle rosette is very simple, consisting of but six or seven nearly equal, roundish cells about .015 mm. in diameter, five or six arranged in a disconnected series around a central one; together they occupy but one-third the diameter of the shallow depression in which they occur and to the edges of which the ribs reach; the central cell is slightly smaller than the others; the floor around them is delicately punctate. Color pale pea-green, becoming salmon red in two days. Breadth, .56 mm.

Caterpillar. First stage. Head (80:30) piceous; body pale green, almost colorless when hatched.

Second stage. Head (80:36) black, with white hairs. Body livid green with a brownish tinge, similar hairs and no markings. Legs pale, slightly tinged with brown; dorsal shield of first thoracic segment scarcely darker than the body.

Third stage. Head (80:42) scabrous, rust red with a circular spot of a paler, somewhat yellowish color, occupying the space between the ocelli and the base of the triangle; collar black; ocelli black; basal joint of antennae broad and pale, others blackish fuscous, the bristle pale; labium pale, the palpi black-ringed; mandibles and labrum blackish testaceous. Body very pale green, covered profusely with white or colorless, fungiform, very short and minute hairs springing from pale warts, arranged in tolerably regular, transverse rows and collected, on the abdominal segments, in a lateral line. Front part of first thoracic segment smooth and pallid and the rest of it like the other segments, there being no distinct dorsal shield. Legs and prolegs pallid with a greenish tinge, the claws of former slightly infuscated; stigmata pale luteous. Length, 10 mm.; breadth, 1.6 mm.; breadth of head, 1.5 mm.

Fourth stage (77:5). Head (77:4) black, a little glistening, with delicate, raised and rather dense reticulation and extremely short, sparse, gray pile, the summit of each hemisphere with half a dozen slight, rather elevated tubercles; posterior surface smooth, piceous; three small, subequal, circular, orange spots, one just in front of the summit tubercles, one subtriangular or transverse at base of mandibles, and one laterally midway between these, generally a little smaller and sometimes fainter than the others. Third joint of antennae piceous, the rest livid; incisure of clypeus and basal joint of labial palpi livid, other mouth parts black. Ocelli piceous. Body pallid with a slight infuscation and a very faint greenish yellow tinge, especially at the incisures. Papillae faint yellowish pallid, forming a very inconspicuous, slender, faint yellowish, lateral line, and a broader but even fainter, infrastigmatal stripe, the latter not wholly made up of papillae. Legs, prolegs and stigmata of the color of the body, the claws of the first slightly testaceous. Length of body, 12.5 mm.; breadth of same, 2 mm.; of head, 2.25 mm.

Last stage (77:3, 6, 10, 11). Head (77:2) strongly vermiculate with short, white hairs, each side produced above into a slight, rounded prominence; color varying from pale greenish fuscous to pale fawn-color; the sides of the head, including the prominence, but not extending down to the middle line, together with a large rounded spot between the ocelli and triangle pale salmon color or orange; sometimes, or perhaps most frequently, the color of the sides is broken up into large rounded spots, so that there are three, one at the prominence on the summit of each hemisphere, another, sometimes more or less confluent with the first, in the middle of the side posteriorly, and the third, generally more distinct than the others, between the ocelli and the base of the triangle at the lower outer angle of the head; posteriorly the head is faint orange,

sometimes confluent with the uppermost spots and the collar is black; the triangle is slightly paler than the ground; the numerous tubercles concolorous, glistening; ocelli pellucid, the upper ones partly greenish, each set in a dark fuscous or blackish basal ring, and which is more or less confluent; labrum luteo-fuscous; labium milk white at base, more or less luteo-fuscous beyond; first joint of antennae milk white, beyond brownish fuscous, bristle white; tips of mandibles castaneous, broadly piceous at edge.

Body varying from dark green to a very clear, pale, waxy green, so besprinkled with small, rounded, pale yellow papillae, each giving rise to a very short, blackish fuscous hair, as to tinge the whole surface with yellow, and which by avoiding the transverse inclures render them more conspicuous and yellowish. There is no dorsal line excepting the mark of the dorsal vessel, but a pale lemon yellow, straight, lateral line over all the segments but the first thoracic and last abdominal; the last abdominal segment is edged with pale yellow; the first thoracic segment is yellowish green, smooth, in front slightly produced angularly in the middle; spiracles pale straw yellow, inconspicuous; legs and prolegs of the same green color as the body, the claws of the former black or blackish. Length of body, 22.5 mm. to 25 mm.; breadth of body, 4.25 mm. to 6 mm.; breadth of head, 3 mm. to 4 mm.

Chrysalis (85:33). The whole upper surface pale or livid, the abdomen faintly tinged with salmon both above and below, the metanotum slightly infuscated; all the appendages of head and thorax, excepting the apical half of basal joint of antennae, the eyes and the space at the sides of the eyes between them and the antennae pitchy black or blackish fuscous, the disk of the wings dark olivaceo-fuscous; eyes slightly infuscated; prothoracic stigmata black, the upper surface covered very sparsely with short, delicate, pale, curving hairs, on the hinder part of the abdomen directed backward; cremaster blackish; hooks dark reddish; the wing broadly mammillated in the middle; spiracles colorless; tongue extending a very little beyond the wings but bordered on either side by an extension of membrane, which together with the tongue forms a small blunt triangle, reaching nearly to the middle of the sixth abdominal segment; wings extending to middle of fifth abdominal segment. Length, 14 mm. exclusive of cremaster; height, 4.1 mm.; width of head at eyes, 4.5 mm.

Geographical distribution (28:7). This butterfly extends over nearly or quite the whole extent of the Alleghanian and Carolinian faunas. In the north, however, it becomes very rare toward the Canadian fauna, the extreme localities where it has been found being Ottawa, rare (Fletcher) and London, Ont. (Saunders), Rockport, O. (Kirtland), southern Michigan, "not common" (Harrington), northern Illinois (Worthington), Wisconsin, not rare (Hoy) and Ames, (Osborn), and Davenport, Io. (Putnam). It is found in abundance as far south as South Carolina (Atkinson), Georgia (Abbot, Morrison) and Florida,—Appalachicola (Chapman, Thaxter), St. John's River (Norton), Crescent City (Hubbard); Okahumpka (Maynard) and even Florida Keys (Maynard). It has also been taken in Dallas (Boll) and according to Aaron in southern Texas. It has more frequently been taken in the interior than most of the species of the genus, for besides the localities given above, it is given from various parts of New York and Pennsylvania and from Missouri (Riley), and is even reported from Colorado, including among other stations the top of Douglas Mountain (Putnam, Lintner), and New Mexico (Snow), but I think these localities may need verification. It is also stated by Boisduval and later by Butler to be an inhabitant of California,

but undoubtedly by error, for one of the western species. Gundlach also formerly quoted it from Cuba, but no specimens from that island have come to my notice, and latterly he has referred what he had considered this species to *T. jaruco*.

In New England it is confined to the south, the northernmost localities from which it has been reported being Milford, N. H. "rare" (Whitney), Amherst (Parker), Belchertown (Sprague), Andover (Seudder) and Foxboro, Mass. (Emery). In Connecticut and the southern half of Massachusetts, including Cape Cod and the Connecticut valley, it is very abundant.

Haunts. The butterfly is most abundant in open oak thickets or by roadsides near them, where it is fond of resting on the wet sands. One may sometimes take them upon the flowers of everlasting, on dry hillsides in the neighborhood of oak woods. Harris states that they are found in meadows, but if found there it must be in the vicinity of woods or shrubbery; hilly pastures would be more probable.

Oviposition. The eggs are laid singly. The only one I have seen laid naturally was laid upon an oak twig, crowded up next to a leaf scar as if for protection; but it is probable that they are laid also upon leaves, and perhaps, from the ordinary habit of the caterpillar to construct its nest by working from the under side, usually upon the under surface. This one hatched, in June, in eight and a half days.

Food plants. Oak seems to form the principle food of the larva in the north. Small plants growing in forest clearings seem to be favorites and Abbot specifies the "narrow leaved winter green oak," which Dr. Chapman thinks must be one of the varieties of the willow oak—*Quercus phellos* Linn. I have found it abundantly on the scrub oak, *Quercus ilicifolia*, and Riley has found it on white oak, *Quercus alba* Linn., and the chestnut oak *Q. castanea*?. Edwards sent me a specimen reared by him in West Virginia on filbert (*Corylus*). Dr. Harris states that it feeds also on the ground nut, *Apios tuberosa* Moench, and the vetchling—*Lathyrus*; Abbot and Smith figure it upon *Galactia pilosa* and Abbot says it lives also upon "wild indigo" (perhaps *Galactia glabella*)—all, excepting the *Cupuliferae*, members of the pulse family, *Leguminosae*.

Habits of the caterpillar. Like the other species of the genus this caterpillar constructs a retreat for itself by folding a portion of a leaf and fastening it in the desired place by silk (82: 1, 2); usually the leaf is bent downward and the under surface of the leaf forms the walls of its abode; at other times, however, the reverse is the case, the caterpillar living on the upper surface, and the nest is then easily discoverable from the contrast which the duller color of the reversed portion bears to the uncovered part of the upper surface; the edges of the leaf are fastened together at considerable intervals by long strands of golden colored silk, very strongly attached at the extremities; the openings left at the side—for the edge of the reversed

portion is not brought to the very surface of the leaf—are also often covered by a thin net work of delicate, tissue-like silk of the same color. Riley states that one found by him “had fastened a lobe of one leaf to another leaf just below it with stout cords of a yellowish silk; the base of each of these cords was broadened so as to give more strength to the cord; the worm,” he adds, “is very courageous and if touched on the abdomen, turns around and endeavors to bite the intruder, and it is with the greatest difficulty that one can remove the worm from its tent without injuring the cords, on account of the resistance of the caterpillar”; this I have also found to be the case.

It travels on the leaf some distance from its nest for food, even in its earliest stage. One hatched in confinement did not at first build any nest, but resided generally on the under surface of the leaf. I removed it to the upper side of a fresh oak leaf. It travelled for an hour or two, over to the under surface and then back again, and finally took up its residence on the upper surface, ate a cut about a millimetre deep at the edge of the leaf and during the next night the parenchyma of the upper surface at a little distance from it. Then it returned to its station on the upper surface and remained there. It is impatient, however, of confinement in early life. This one died before moulting, and another in its third stage, shut up in a jelly glass with oak leaves, appeared very unhappy, wandering everywhere, off as much as on the oak leaves, which were perfectly fresh. On leaving an old nest to construct a new one, when half-grown, it always bites off the silken strands of its old abode.

It ordinarily rests quietly by day upon the upper surface of its nest, back downward, feeding or working only by night; when disturbed, it opens its jaws widely and scrapes the surface of the leaf backward rapidly and repeatedly, making a scratching noise on the rough veins of the leaf. About the middle of September or sometimes not until the middle of October,* the caterpillar stops feeding and begins at once to close all the openings to its abode with a slight, but very tough silken film; this occupies four or five nights; the whole cavity is also lined thinly with silk to enable it to move securely to any part. Should any accident afterwards happen to the nest, the whole is at once filled anew, but the silk is then of a white color.

Riley remarks that “the color of these larvae is of the same pale bluish green as the lower surface of the leaves of the chestnut-oak [on which he found them] and the whole surface is covered with small roundish, very pale yellowish-white spots,” which Mrs. Peart observes are so closely crowded as to give the caterpillar a mealy appearance. When ready for

* It sometimes moults for the last time when most of the leaves are brown and none entirely green, and I have had the moult occur within

doors as late as October. Indeed the caterpillar eats more or less until the last week in November.

hibernation the color of the body has changed to a very pale vinous tint, not unlike that of many dried leaves, and the head to a dull yellowish brown, in no great contrast to that of the body.

Pupation. When, in the early spring, the insect feels the time for pupation approach, it gnaws a passage through the end of its nest and constructs another—at least in confinement; probably also in nature, for it would hardly be possible for the imago to escape from such a retreat; perhaps, as the leaves of the oak fall at about this time, it makes its way to the surface of the ground and there constructs a suitable cocoon. Indeed Harris expressly says the “cocoon is composed of stubble.” Specimens bred in confinement, finding nothing better than old oak leaves as dry as those they had left, managed from these poor materials to construct a case similar in general form to the one they had left, drawing together and bending the dry leaves into the semblance of a cocoon very slenderly protected, constructed of but very few cords and lined with a few glistening threads; the surface where they rested immediately previous to their change and the points of support of the Y-shaped shrouds were, however, more liberally supplied; the anterior Y-shaped shroud supported the hinder portion of the mesothorax; in one instance its stem was 2.25 mm. long and each of the arms 6.7 mm. long; a very thick cord about 4 mm. long, mingled with a web, parallel to the Y-shaped band and having an ill-defined resemblance to it, occupied the posterior extremity and into it the crotchets of the cremaster were plunged.

Life history. This butterfly is double brooded in the south and probably also in the north, although the records of a second generation in New England are exceedingly few. Here it winters as a full fed caterpillar and during the month of March or at the beginning of April changes to a chrysalis; in this condition it remains a full month and then takes flight. It is one of the earliest species of *Thanaos*, making its advent in the first days of May, and was once observed by Miss Guild on April 28th; the female generally follows the male in a little more than a week and both sexes continue to emerge from the chrysalis until after the middle of May, the female probably nearly until the end, and they continue to fly in faded condition until somewhat past the middle of June. They are most abundant about the middle of May. The eggs are laid between the middle of May and the middle of June and a second brood of butterflies, much less numerous,* appears about the 20th of July continuing through most of August. It is highly probable, from the ordinarily slow growth and habits of the larva and from the small numbers of the second brood, that most of the caterpillars of the first brood feed until autumn, those of both broods becoming full grown between the middle of September and the

* Maynard says it appears “in great numbers in July,” as if this were its special season; but in this, as in too many other cases, his observations are mixed.

middle of October and, sealing up the openings to their nests, betake themselves to their winter's sleep.

In Georgia, according to Abbot's observations, the caterpillar closes its nest in the autumn at the beginning of October, changes to chrysalis during the first week in February and remains in this state about three weeks, appearing thus about two months earlier than in New England; individuals of the second brood appear sometimes as early as the end of June, sometimes as late as the first of September (after eight days in the chrysalis), if these dates are not rather indicative of three generations. Mr. Edwards reared a male in West Virginia on May 24.

Habits of the butterfly. The butterflies, remarks Maynard, are fond, like other species of the genus, "of alighting in sunny places on the ground but are constantly on the alert, instantly flying when approached too closely."

When at rest with expanded wings the antennae are held parallel to the body, divaricating about 135° and straight as far as the club, which is curved backward and droops to an equal degree.

Parasites. Two hymenopterous parasites have been bred from the caterpillar, *Apanteles flavicornis* by Mr. Riley and *Microdus sanctus* (88: 10) by myself. The latter was black in life, with the belly, hind coxae, hind femora except the base, and the hind tibiae excepting apical fourth, red. A female emerged about October 1st and another on October 8th.

Desiderata. The summer history of this butterfly both north and south needs careful investigation; the proportionate numbers of the broods should be stated, or whether a second generation always occurs; the egg is not certainly known and characteristics of the flight of the butterfly undescribed. It is highly desirable that the eggs should be obtained from a known female and the larval stages followed and described afresh; of the first two stages in particular too little is known; and they should be reared in considerable numbers to see if there is any difference in the development of different individuals, sufficient to account for the poverty of the second brood of butterflies.

LIST OF ILLUSTRATIONS.—THANAOS JUVENALIS.

General.

- Pl. 28, fig. 7. Distribution in North America.
88: 10. *Microdus sanctus*, a parasite.
Caterpillar.
Pl. 77, fig. 2. Front view of head, stage v.
3. Side view of one segment.
4. Front view of head, stage iv.
5. Fourth stage, side view.
6, 10, 11. Mature caterpillars.
80: 30, 36, 42. Head, front view, stages I-III
82: 1, 2. Nests.
86: 49-51. Dermal appendages at birth.

Chrysalis.

- Pl. 85, fig. 33. Chrysalis.
Imago.
Pl. 9, fig. 13. Male, both surfaces.
14. Female, upper surface.
36: 24-27, 34, 35. Male abdominal appendages.
41: 7. Neuration.
43: 12. Fore wing showing open costal fold.
47: 5. Scales of male imago.

THANAOS HORATIUS.—Horace's dusky wing.

Nisoniades horatius Scudd.-Burg., Proc. Bost. soc. nat. hist., xlii: 301-2, fig. 13, u, ub, l, r (1870); — Park., Can. ent., iii: 113 (1871).
Erynnis horatius Scudd., Syst. rev. Am. butt., 51 (1872).

Papilio juvenalis Abb., Draw. ins. Geo. Br. mus., vi: 72, figs. 97, 98, 198 (ca. 1800).

Nisoniades juvenalis pars Streek., Cat. Amer. macrolep., 177 (1878).

Nisoniades virgilius Scudd.-Burg., Proc. Bost. soc. nat. hist., xlii: 302-303, fig. 14, u, ub, l, r (1870).

Erynnis virgilius Scudd., Syst. rev. Am. butt., 51 (1872).

Oh restlessly
 The gay Sweet-pea
 Nods on her slender stem,
 For far up in the sunny skies
 She sees the sailing butterflies,
 And longs to go to them.
 For why should they
 Be first to say,
 "We love thee, pretty maid!"—
 Why for their coming must she wait,
 Nor speak of love till they dictate,
 Though Time her wings should fade?
 She wonders why
 She must not fly,
 Her warm heart's love to say—
 Her pink and white and scarlet wings
 Were surely made for better things,
 Than thus at home to stay!

MARGARET DELAND.

Imago (9:7, 10). Head covered with dark gray-brown hairs with a very inconspicuous edging of pale scales next the eye and particularly just behind the antennae; occasionally a very few white hairs occur midway between the hinder edges of the two antennae, and the anterior facing of the hairs in front of the antennae which rest upon the palpi is also pale; tuft on outside the antennae black; palpi dark gray from a commingling of pale brown, and dark brown hairs and scales, most of which are pale tipped; rather darker above than below, the apical joint wholly dark brown; antennae dusky brown, tinged with yellowish and uniform, the base of the joints of the stalk distinctly touched with white beneath and especially anteriorly, where on the basal five or six joints it is confluent, forming a longitudinal stripe; above the club is a little darker than the stalk; beneath, it is bathed in silvery gray posteriorly, naked and dark griseous anteriorly, becoming tinged with castaneous toward the tip, sometimes wholly castaneous, the upper as well as under surface of the terminal joint being of this color. Tongue blackish fuscous, dark castaneous at the sides, becoming luteo-castaneous apically.

Thorax covered with nearly uniform, very dark brown hairs, below with similar ones, sometimes with a purplish or grayish tinge. Legs uniform dark, slightly purplish brown, paler beneath, the tarsi beneath reddish luteous; spurs dark brown, minutely reddish tipped; spines reddish luteous; claws dusky reddish; pad blackish.

Wings above soft cloudy blackish, sometimes dark grayish brown, marked inconspicuously with still darker spots. Fore wings usually more grayish in the ♀ than in the ♂; they are also marked with small vitreous or occasionally dull silvery white spots; one of these, usually square, crosses the upper half of the cell between the bases of the first and second superior subcostal nervules; the others form a series almost invariably broken, four being found above in the subcostal interspaces and one or two below in the median interspaces, the lower sometimes obsolete; in a single example under examination, these are all united by similar spots in the intervening interspaces to form a perfectly uniform arcuate series; in general the four upper spots are rather smaller than the upper median one and are unequal, the upper and lower being ordinarily equal, the middle ones elongate, the upper of them extending toward the apex, the lower toward the base of the wing; but occasionally they are all elongate; they

form a straight series extending from the middle of the outer two-fifths of the costal margin toward the middle of the outer border; the median spots when both are present are in a line nearly at right angles to this, the outer limit of the upper one being in the centre of its interspace. The wing is crossed by three inconspicuous bands of clouded blackish spots: the inner and broader extends from the upper border of the cell, having the vitreous spot at its outer extremity, to the middle of the basal two-thirds of the submedian nervure; its inner border is obscure but its outer passes from above downward in successive equal steps at the nervures, crossing each interspace at right angles, filling the entire base of the upper median interspace; sometimes this belt is reduced to a pair of similar, longitudinally oval, blackish patches, one above the other, in the cell and a similar pair in the medio-submedian interspace; the middle curving band extends from the costal margin to the submedian nervure and lies midway between the inner band and the outer border including, next its inner border, all the vitreous spots; the spots of which it is composed are slightly more distinct than those of the inner band though sometimes scarcely distinguishable and, above the lower median nervure, are generally elongate triangular, twice as long as broad, the apex outward, but above, next the vitreous spots, they degenerate into uniform dashes and below the median become irregularly quadrate; the wing is frequently flecked with short longitudinal white hairs or, toward the apex of the wing, hoary scales, which are more abundant than elsewhere upon the borders of the two bands just described, tending often to accentuate them or to enliven the paler parts with a grayish tinge; the outer band consists of a submarginal regular series of very nearly equal spots similar to the others but roundish and scarcely half so broad as the interspaces, often accompanied externally by a slight and limited pale flecking; usually the outer margin of the spots is more distinct without this aid, especially in such as have the spots of a roundish, sagittate form, the apex outward; outer margin narrowly edged with blackish; fringe uniform dark brown, generally slightly paler than the general ground color of the wing. *Hind wings* of a nearly uniform tint, not quite so dark as the darkest parts of the fore wings, a little before the hind margin enlivened by paler, yellowish brown, roundish spots, almost never at all defined and usually giving only the effect of a paler, indistinct, clouded, interrupted band in the middle of the outer two-fifths of the wing and parallel to the outer margin; outer margin edged narrowly with blackish; fringe as in the fore wings, but paler in the outer half, occasionally very minutely white-tipped.

Beneath dark purplish brown, on the hind wings uniform, on the fore wings paling toward the inner margin, where it becomes pale slate brown. *Fore wings* with the vitreous spots larger and more distinct than above, the obsolete ones often present and the whole edged obscurely with dusky, so as often to give the semblance of an extra-mesial dusky band; beyond this the wing is a very little lighter, rendering more distinct the always obscure repetition of the submarginal spots of the upper surface, which here are larger and are generally followed by faint, lighter fleckings exteriorly; all these markings are much more distinct in the ♀, which has a few scattered, hoary scales near the tip of the wing; outer border narrowly edged with blackish brown; fringe of the ground color of the wing, but a little paler at the base. *Hind wings* with the dull, obscure markings of the upper surface repeated with the same vagueness and faintness, excepting in the ♀, where the dark spots are not in themselves more distinct, but they are touched on either side by minute spots of dirty white, exteriorly often in the form of short, longitudinal streaks leading to the border; margin and fringe as in fore wings.

Abdomen very dark brown, tinged above with purplish, below grayish brown. *Upper organ* of male appendages (36: 13-14) having the centrum long and slender, not high. Posterior extremity bearing greatly elevated asymmetrical alations, united in a somewhat horseshoe-shaped or semi-infundibuliform, curving, hollowed plate or crest, excessively produced as a slightly upraised, pointed triangle on the right side, directed backward and upward; the whole crest faces upward and backward, its united upper edge fringed with minute spicules, and is supported on either side by a slender ridge

running from near its middle a short distance forward to the side of the main body. Hooks very small, asymmetrical, the right being much the larger, pointed, scarcely curving downward at tip, approximate at base, divergent; tooth small, sessile, spatulate or obpyriform, appressed. Arms asymmetrical, very slender, nearly uniform, curving, having first a general direction downward and slightly forward, afterwards backward, upward and inward, the curve quite regular, expanding slightly at tip and bearing between the extremities the inferior armature—a rather small, rounded field of minute, raised points. *Left clasp*: Main body broad and rather short, slightly gibbous, the upper edge full at base, the lower nearly straight. Blade moderately long, the upper three-fourths bent over inward so as to be horizontal, or on the basal half slightly deflected, nearly equal in width, but a little constricted near the middle, the apical fourth tapering to a bluntly rounded apex, which is curved slightly downward; viewed laterally, the blade tapers regularly and slightly and is straight and horizontal; viewed from above, it curves a very little inward; basal process developed as a slender, scarcely compressed dactyl, bent over backward from its origin, so as to be nearly horizontal on a lateral view, scarcely curving inward, nearly one-third as long as the blade, a little enlarged beyond the middle, and armed with a few very minute spinules around the edge of the enlarged portion. The lobe consists of an upward prolongation of the upper hind angle of the main body into a bluntly pointed triangular expansion, curving inward, leaving the apical border of the main body straight, and at right angles with the lower margin. *Right clasp*: Main body much as on the opposite side, but the upper portion of the base not so full, and beyond the middle the upper border is slightly elevated. Blade broad, not very long, directed slightly upward, especially at the tip, slightly excised along the middle, larger at the apex than at the base, gibbous at the base, beyond flat, twisted so that the outer surface becomes nearly horizontal, curved slightly inward, the apex, especially the upper angle, still more so, the tip docked almost squarely and a little diagonally, so that the apical edge is directed almost straight backward, very broadly rounded, the edge slightly thickened, the angles not sharp; basal process consisting of a small, backward directed, triangular tooth, bluntly pointed and as long as the smallest breadth of the blade. Lobe consisting of an upward, posterior projection of the upper hind angles of the main body, forming a subtriangular, broadly rounded, gibbous pad, curving inward and a little backward, separated from the basal process of the blade by a very broad, deep and regularly curved excision.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 9.75 mm.						
Length of fore wing.....	16.75	18.75	20.5	16.5	17.25	19.
antennae.....	8.75	9.1	9.6	8.4	8.55	9.8
hind tibiae and tarsi..	6.9		7.75	7.	7.6	7.85
fore tibiae and tarsi..	4.5	5.	5.25	4.5	4.65	5.15

Described from 31 ♂, 4 ♀.

Accessory sexual peculiarities. The costal fold of the fore wing of the male encloses a dense clustered mass of pediform bristles (47: 10c) rather more than 1 mm. long; and androconia (10 a, b) and cover scales (10 c, d) different in no essential feature from those of *T. juvenalis*.

Caterpillar. *Last stage.* Head black, minutely pubescent, depressed at the vertex (subcordate), with a subdentate angle on each side, the upper part of the face and each cheek suffused with dull yellow. Body fusiform, yellowish green, minutely papillose with pale points, with a dark dorsal and a subdorsal bright yellow line, both commencing on the first abdominal segment, and an obscure pale line on the abdominal fold; first thoracic segment yellow, with no band. Length, 19 mm.; breadth, 5.3 mm.

This and the following description by Dr. A. W. Chapman of Florida presumably belong to this species, as the short description and sketch of the imago perfectly agree.

Chrysalis. Glaucous green on the thorax and posterior segments, yellowish green on the others; head case prominent, rounded; a prominent velvety black raised dot at the origin of the round wing covers. Length, 19 mm.

Comparisons. The present species is darker than *juvenalis*; the fore wings scarcely differ in color from the hind wings and are flecked with gray with not half the uniformity that is seen in *juvenalis*; hind wings not enlivened with the pale spots near the outer border to the extent that generally holds in *juvenalis*, especially in the ♀; the submedian chereous spots never occur in *horatius*, and the extra-mesial band of dark spots is less connected and regular in *horatius* than in *juvenalis*.

Distribution (28: 8). Probably this butterfly has a distribution very similar to that of *T. juvenalis* with which it has frequently been confounded, but it is not known from so far in the interior; it is a member of the Alleghanian and Carolinian faunas and has been taken in central and northern Texas (Belfrage, Boll), Florida, both at the Keys and on the St. John's River (Palmer), Georgia "common" (Abbot), North Carolina (Morrison), District of Columbia (Dodge—Mus. Yale Coll.) and Maryland (Weidemeyer).

In New England it has been found only in the southern half and in the following localities—Amherst (Parker), Amherst Notch (Scudder), Foxboro (Emery), Andover (Scudder) and the vicinity of Boston, Mass. (Merrill, Minot, Scudder), and Guilford (Smyth—Mus. Yale Coll.) and New Haven, Conn. (Mus. Yale Coll.).

Food plant. The caterpillar raised by Judge Chapman, which I have considered as of this species, was found on *Wistaria frutescens*.

Seasons. The memoranda concerning its appearance are so meagre that only an uncertain account of its history can be given. It is double brooded both north and south, having been bred March 8 by Abbot* in Georgia, and on August 1 by Chapman in Florida; it was taken in Texas in a fresh condition on July 15 (Belfrage), and again by Palmer, fresh, in the latter part of July at the Florida Keys and in the middle of August on the St. John's. In the north it probably appears at about the same time as *juvenalis*, since I took males at Andover on the 18th of May in the same condition and in the same localities as males of *juvenalis*. That a second brood flies appears from my taking fresh males at Waltham, the last day of June, others, condition not noted, in the Middlesex Fells, July 24; while at Amherst Professor Parker took it July 4 and at Amherst Notch I caught or saw a dozen or two on August 4.

Desiderata. Nothing more is known of its history and every fact is desirable. The too brief descriptions of the caterpillar and chrysalis also need verification, so that our account is nowhere complete.

LIST OF ILLUSTRATIONS.—*THANAOS HORATIUS*.

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| <p><i>General.</i>
Pl. 28, fig. 8. Distribution in North America.
<i>Imago.</i>
Pl. 9, fig. 7. Female, upper surface.
10. Male, both surfaces.</p> | <p>Pl. 36, figs. 13-16. Male abdominal appendages.
47: 10. Scales of male <i>Imago</i>.
57: 7. Side view, with head and appendages enlarged, and details of the structure of the legs.</p> |
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* The species is not absolutely certain.

THANAOS TERENTIUS.—Terence's dusky wing.

Nisoniades terentius Scudd.-Burg., Proc. Bost. soc. nat. hist., xlii: 292-293, figs. 6u, l, r, lb, rb (1870).

Erynnis terentius Scudd., Syst. rev. Amer. buttl., 51 (1872).

Nisoniades ovidius Scudd.-Burg., Proc. Bost. soc. nat. hist., xlii: 295, fig. 8u, l, r (1870).

Thanaos juvenalis pars Streck., Cat. amer. macrolep., 177 (1878).

Each on his reed astride, the Cherub-train
Watch her kind looks, and circle o'er the plain;
Now with young wonder touch the sliding snail,
Admire his eye-tipp'd horns, and painted mail;
Chase with quick step, and eager arms outspread,
The pausing Butterfly from mead to mead.

DARWIN.—*The botanic garden.*

Imago (9:15). Head covered pretty uniformly with rather dark, gray brown scales and hairs, the eye encircled, excepting in front, with slightly paler scales which in a slender space above, and occasionally below, become whitish; tuft of hairs outside the antennae black. Palpi griseous, the dark, gray brown hairs of which it is composed, and which grow darker toward the distal end of the palpi, being pale-tipped; a few longer black hairs are intermingled; the palpi are darker above than below, more seldom or less conspicuously pale-tipped, and the terminal joint is nearly uniform dark gray-brown. Antennae dark purplish brown, darker anteriorly than above, posteriorly heavily flecked with silvery white, or gray, especially on the base of the joints, and which cover the face of the club with a uniform tint; all the joints of the stalk are marked narrowly but distinctly with silvery white anteriorly, but it seldom encroaches on the upper surface; beneath, the whole club is blackish castaneous, excepting at the extreme base and on the apical joint, where it is castaneous.

Thorax covered above with blackish brown hairs, beneath with grayish brown, often purplish tinged, pale-tipped hairs. Legs dull purplish brown, more or less flecked with pale or grayish white scales along the inner side, especially on the tarsi, and occasionally in a less degree at the tip of the femora externally; tarsi beneath dull castaneous; spurs dull brown, flecked with gray, minutely reddish tipped; spines dull reddish luteous; claws dingy red, darker at tip; pad dusky.

Wings above blackish, the hind wings scarcely lighter than the fore wings. Fore wings furnished with very small vitreous spots; one, scarcely more than a dot and often pale instead of vitreous, is found in the cell next the base of the second superior subcostal nervule; the others form a broken series, the upper portion of which consists of four minute but distinct spots, in successive interspaces below the second superior subcostal nervule, the lowest sometimes nearly obsolete, but generally transverse and situated next or even beyond the outer limits of the series which depends from the middle of the outer two-fifths of the costal margin, in the direction of the middle of the outer margin; the three other spots are generally longitudinal dashes, sometimes quadrate, the middle usually the largest; the lower portion of the complete series consists of two spots in the median interspaces, the lower usually obsolete, and when present a mere dot or transverse streak, the upper very small and round in the middle of the basal two-thirds of the interspace; occasionally a single dot occurs also in the lowest subcostal interspace. The wing is almost entirely blackish, blotched very slightly, irregularly and very obscurely on the basal half with scarcely lighter shades. A distinct, but ill-defined, large, roundish patch, reaching from close to the costal border to the bottom of the cell and from the cellular vitreous spot close to the other vitreous spots, is of a considerably paler cinereous, especially in the ♀, often tinged very slightly with rosaceous; similar tints, less frequently rosaceous, cloud the outer margin excepting at extreme tip and make zigzag transverse streaks before the middle of the medio-submedian interspace; the former intensify the generic markings, leaving in their midst a lunulate outer border to an otherwise nearly indistinguishable extra

mesial band, which as usual includes the vitreous spots; a submarginal series of ill-defined, round, blackish spots a little further removed from the border below than above; occasionally a few scattered, white, elongate scales are found along the nervures and in the grayer parts of the wing, especially on the lower and outer half; outer margin edged with blackish; fringe dark fuscous brown, nearly uniform. *Hind wings* very nearly uniform in tint, scarcely so dark as the fore wings, with perhaps more of a chocolate color and furnished on lower half with long delicate hairs of the color of the ground; a faint, marginal row of small, scarcely paler spots; a more distinct sinuous series of similar, slightly larger spots beyond the middle of the outer half of the wing, approaching the border in the upper median interspace and receding from it in the two interspaces above; outer margin edged with blackish; fringe slightly paler in the hind wings, the extreme tip, especially toward the upper outer angle, whitish.

Beneath very dark fuliginous brown, with a faint purplish tinge. *Fore wings* with the whole inner border pale ochraceous. The vitreous spots of the upper surface almost exactly repeated; a marginal row of minute, pale ochraceous, ill-defined spots, increasing in size below the middle of the wing, and a submarginal row of similar, scarcely larger ones, receding slightly from the outer border, and above situated midway between the vitreous spots and the outer border; these spots are more distinct in the ♀ than in the ♂, and the outer row is sometimes reduced above to longitudinal lines; the apex of the wing beyond the vitreous spots has usually a few scattered hoary scales, especially along the nervules, and sometimes forming the upper of the pale spots; outer border edged with blackish. Fringe of the ground color of the wing, slightly paler at extreme tip and overlaid at extreme base with whitish or pale ochraceous scales. *Hind wings* with a double row of faint, pale ochraceous spots, often obsolescent, especially in the ♂, the outer the smaller and marginal, often reduced to longitudinal lines in the middle of the interspaces, the inner sinuous, receding a little from the outer border in the interspaces beyond the cell, but in general parallel to the outer border, extending from the upper subcostal to the submedian nervules in the middle of the outer half or two-fifths of the wing; the anal angle is clouded faintly with ochraceous; border and fringe as on fore wings.

Abdomen very dark brown above, becoming gradually lighter on the sides, and dark ochraceous brown beneath. *Upper organ* of male appendages (36: 17-20, 28, 29) having the centrum small, not very slender, short, not high. Crest protruding upward and somewhat backward into a plump, bulbous ridge, armed with minute points. Hooks very short, very stout, curved, bluntly pointed, widely separate at base, divaricate almost at right angles; from the middle of the ridge, uniting their bases, depends a short, rather small denticle, bluntly conical on a side view, very broadly obovate on a hind view. Base of the lateral arms greatly produced in a posterior direction; otherwise directed downward, then bent at more than a right angle backward, the lower edge very soon expanding quite broadly, so as to meet the similar portion of the opposite one beneath, and bearing upon this united belt the inferior armature which occupies, with its minute raised points, a very large and broad field, reaching nearly to the base of the terminal hooks. *Left clasp*: Main body pretty broad, base obliquely and very largely docked above, upper margin deeply, broadly and roundly excised just before the lobe; transversely it is a little gibbous, and longitudinally a very little curved. Blade very long, compressed, its upper edge a little incurved, giving it a solid appearance, gradually twisted so as to bring the outer surface uppermost; it diminishes in size very gradually to the tip, curving very slightly inward in continuation of the curve of the main body; viewed laterally it is slightly sinuous in its course, the apex bent inwardly nearly at a right angle, rapidly tapering, terminating in a somewhat blunted point, armed with minute serrulations; basal process directed upward and somewhat backward, bent also a little inward, especially by a twist of the hinder edge; it is small, somewhat longer than broad, broader at tip than at base, its hinder edge straight and smooth, its front and upper edge rounded and conspicuously armed with minute teeth, which are borne also, to some degree, upon the outer surface near the tip; at the base it is very closely connected with the lobe. Lobe forming a very broad and very short

flap, directed upward and a little outward, its apex scarcely at all rounded, but the outer angle produced into a small, incurved, rounded pad. *Right clasp*: Main body similar to that of the other side, with rather deeper excisions and more prominent projections. Blade exceedingly broad and short, its outer surface gibbous, especially near the apex, and twisted a little in its course so as to bring its outer surface somewhat upward, its curve the continuation of that of the main body, as on the opposite side, the lower edge directed a little upward with a sinuous curve, the upper edge curved upward, the apex broader than the base, squarely docked, the lower angle rounded, the upper square, almost produced and armed with a few minute spinules beyond the central excision of the apical edge; basal process almost entirely concealed; it is a small, narrow, appressed, dentiform, bluntly pointed piece, directed almost straight inward from the base of the upper edge of the blade. Lobe exceedingly broad and very short, nearly twice the breadth of that of the opposite side, and having a similar direction, its apical border excised, the angles forming the upper and hind processes, the former well rounded, gibbous and incurved, the latter greatly produced as a prolonged flap, uniform in breadth, well rounded at apex, gibbous and bent strongly inward at right angles, crowding against and concealing the basal process of the blade, which it equals in length, and almost coming in contact with the blade itself.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....		20.		18.2	19.75	21.2
antennae.....		9.25		9.4		10.1
hind tibiae and tarsi....		7.25		7.25		8.
fore tibiae and tarsi....		5.		5.	5.1	5.2

Described from 1♂, 3♀.

Accessory sexual peculiarities. The costal fold of the fore wing of the male encloses a dense clustered mass of pediform bristles (47:9 f) about 1.25 mm. long; androconia (9 a-d) of varying shapes, and large cover-scales (9 e) differing in no apparent way from those of *T. juvenalis*.

Comparisons. This species is darker even than *T. horatius*, but differs especially on fore wings by the distinct, cinereous patch at the tip of the cell and cinereous clouds next outer border, which are present only with greatly diminished force in the female of *T. horatius*; the vitreous spots average much smaller and especially the lowest of the subcostal series is more frequently smaller than any of the others, and the cellular spot is always minute or obsolete. It differs from *T. juvenalis* in the greatly diminished size and abundance of the vitreous spots, the lack of pretty uniform gray flecking over the fore wing, the even otherwise much darker color and the much less clearly defined, darker bands; so, too, the distinct, cinereous patches of the outer half of the wing are wanting in *T. juvenalis*.

This butterfly is doubtless found through the whole latitudinal range of the Carolinian and Alleghanian faunas (28:6), but only east of the Alleghanies and mostly near the seaboard. From south northward the places from which it is known to me are Appalachianicola (Thaxter) and other parts of northern Florida, Georgia, South Carolina (Atkinson) and North Carolina (Morrison).

It is not again reported farther north until we reach New England, where it has been taken in Farmington, Conn. (Norton) and Deerfield, Mass. (Sprague).

As to its seasons we know nothing except that it must be double brooded, as Mr. Sprague's specimen, a female, was taken August 13. It is there-

fore unnecessary to say more than that every point in its history, to the date of capture of each specimen and its condition, is desirable.

LIST OF ILLUSTRATIONS.—THANAOS TEREINTIUS.

- General.*
Pl. 28, fig. 6. Distribution in North America.
Imago.
Pl. 9, fig. 15. Female, both surfaces.
- Pl. 36, figs. 17-20, 28, 29. Male abdominal appendages.
47: 9. Scales of the male imago.

GROUP III (martialis).

Antennal club composed of twenty-one or twenty-two joints; fore wings with or without subapical vitreous spots; hind coxae and tibiae with no special apertures; costal fold of fore wings of male with pediform bristles and apple-seed shaped androconia; upper organ of male abdominal appendages with an unarmed, laterally expanded crest; terminal hooks separate, of moderate size; tooth stout, conical; clasps with stout blades bent at right angles beyond the middle, the right lobe dactylate, the left with united basal and median processes, unarmed. Eggs with eighteen or more vertical ribs. Larval food, Leguminosae. Two broods annually in the northern United States.

SPECIES: *martialis*, *ausonius*.

THANAOS MARTIALIS.—Martial's dusky wing.

[Least dingy skipper (Abbot); dark banded skipper (Maynard).]

Nisoniades martialis Scuddl., Trans. Chic. acad. sc., 1: 335 (1870);—Scuddl.-Burg., Proc. Bost. soc. nat. hist., xiii: 291-2, fig. 5 l, r, u (1870);—Park., Can. ent., iii: 113 (1871);—French, Butt. east. U. S., 362-363 (1886).
Erynnis martialis Scuddl., Syst. rev. Am. butt., 51 (1872).
Thanaos martialis Mayn., Butt. N. Engl., 55, pl. 81, 81a (1886).

Papilio—Abb., Draw. ins. Geo., vi: 74, fig. 43; xvi: 50, tab. 136 [error for 176] (ca. 1800).

Thanaos quereus Bois., Butl., Entom. monthl. mag., vii: 97 (1870).

Figured also by Abbot, Draw. ins. (Ga., Ocmulgee coll., Bost. soc. nat. hist., 31;—Glov., Ill. N. A. Lep., pl. T, figs. 8, 14, ined.

Die Liebliche, die zagend nur und lose
Der laue Hauch mit Geisterlippen küsst,
Indess von fern die Schmetterlinge fliegen
Und mit dem Duft bescheiden sich begnügen.

SCHULZE.—Die bezauberte Rose.

When daffodils begin to peer,—
With, heigh! the doxy over the dale,—
Why, then comes in the sweet o' the year;
For the red blood reigns in the winter's pale.

SHAKESPEARE.—Winter's Tale.

Imago (9:12). Head covered with nearly uniform, very dark brown hairs, tinged with purplish, those on the front, next the palpi, often almost entirely pale; a narrow, but sometimes rather conspicuous belt of pale scales behind the eye, repeated above behind the antennae at the border of the eye; tuft of bristles outside the antennae black. Palpi covered with pale-tipped, very dark brown hairs, some shorter ones on the sides uniform and paler than the base of the others; those on the inner side dark slate blue; the whole under surface, but especially the outer edge, covered with frequent black bristles, a little longer than the scales; above, the scales are less frequently, sometimes not at all, pale-tipped; terminal joint very dark brown above, slightly paler beneath. Antennae dark purplish brown, the joints of the stalk marked inconspicu-

ously above with dull white at the extreme base, distinctly beneath, both in front and behind, with snowy white on the basal half, and behind also, on the apical half of most of the joints, especially toward the club, either a little less distinctly than on the basal half, or with a distinct dash along the middle, growing more and more conspicuous, until on the club all merge into a uniform field of white; the lower anterior half of the club naked and dark castaneous, the upper half of the field dusky, but the apical joint wholly naked and castaneous. Tongue dull black, changing to luteous at extreme tip.

Thorax covered above with mingled dark brown and blackish hairs and scales; beneath with scarcely pale-tipped dark brown hairs tinged with purplish. Legs dark, purplish brown, more deeply tinged with purple and otherwise darker above than beneath, the upper surface of the tarsi not so dark as that of the femora, occasionally flecked with ashen, or pale along the inner surface. Spurs purplish brown, flecked with ashy, and tipped with pale reddish. Spines dull luteous; claws the same at base, reddish at tip. Pad blackish.

Wings above very dark, warm brown, tinged slightly with vinous, especially on the fore wings. *Fore wings* with a cellular, vitreous spot and an extra-mesial series of similar ones; the cellular spot is generally obsolete in the ♂ and in the ♀ scarcely ever more than a roundish dot, situated just beneath the base of the second superior subcostal nervule. The outer series consists of distinct subcostal and median sets; the subcostal of four minute, generally unequal, quadrate or oblong spots, the lower occasionally and rarely all but the second from the top obsolete, situated in the successive interspaces below the second superior subcostal nervule, the middle ones usually the largest, the series scarcely larger in the ♀ than in the ♂, and arranged in a straight or nearly straight line extending from the base of the first superior subcostal nervule to the middle of the outer border; the median spots are occasionally both obsolete, the lower frequently in the ♂; when present they are generally, especially the upper, a very little larger than the others and are placed somewhat before the middle of the two median interspaces; in a single ♀ only is there a dot in the lowest subcostal interspace. The extreme base of the wing is obscured by dark clouds, while the other dark markings, excepting at the outer border, are darker than usual, being almost velvety black; the intra-mesial band is of irregular width and interrupted; it extends from the costal margin, its outer limit at the tip of the costal fold of the ♂, to the middle of the basal two-thirds of the submedian nervure and is composed of two parts, divided, or sometimes united slenderly at the median nervure; the upper portion is broad, of nearly equal average width, crossing the wing at right angles to the costal margin, strongly strangled in the middle of the cell and expanding again on approaching the median nervure; the lower portion is usually narrower, crosses the medio-submedian interspace at right angles, its interior limit striking the base of the lower median nervule, is generally lanceolate and often sends a slender shoot, sometimes a rather broad one, across the base of the lower median interspace to join the upper portion; the cell is also crossed midway between the intra-mesial band and the base of the wing by a narrower bar or lunule, the lower outer angle of which joins the lower part of the intra-mesial band; the extra-mesial band is usually of about the width of the upper portion of the other and of the medio-submedian interspace, of equal average breadth throughout, rather strongly sinuous in direction, passing from the costal margin midway between the tip of the costal fold of the ♂ and the tip of the wing to the middle of the outer two-thirds of the submedian nervure, enclosing at its interior edge the subcostal vitreous spots and just within its middle the median vitreous spots. Above the median area and especially in the interspaces beyond the cell the spots are often less intense and always have their interior limits less clearly defined than below, where the edges are marked with unusual clearness, being regularly undulate, opening toward the base in the interspaces; externally the spots are lanceolate, especially in the upper half of the wing, and the lowest are usually followed outwardly by a paler, grayish area, reaching to the submarginal spots; the submarginal series consists of independent roundish spots, increasing in size, becoming more and

more lunulate and receding slightly from the outer border in passing downward, although the uppermost ones are often larger than those in the middle of the wing; the spots are not so deep in tint as the other darker markings of the wing and they are often followed exteriorly by faint, pale points. The space between the extra-mesial and submarginal bands is filled, almost uniformly and rather profusely, but below sometimes more abundantly next the former, with elongated, pale lilaceous scales; minute crescents of the same, opening inward, are seated upon the outer border in the interspaces, and similar scales edge very slightly the interior border of the extra-mesial band and both borders of the interior bands, in the former especially upon the lower, in the others especially upon the upper half of the wing; a few elongated, hair-like scales are scattered along the costal margin as far as the upper third of the cell but stop short before reaching the subcostal vitreous spots; outer margin edged narrowly with black, slightly thickened at the nervures. Fringe of the ground color of the wing, a little darker toward the base than at tip, the basal half flecked with white beyond the middle of the interspaces. *Hind wings* with a submarginal, regularly arcuate series of ill-defined, roundish, dusky spots, and a strongly sinuous series of similar, often confluent, dusky spots, crossing the middle of the outer two-thirds of the wing, each followed outwardly by indistinct, pale spots, corresponding to those found in the other species, but generally less distinct here and sometimes forming a faint, pale cloud between the rows of dark spots. Outer margin edged with black, slightly broadened at the nervure tips; fringe of the lighter color of the wing, clouded with black toward the base, especially next the nervure tips, and next the interspaces overlaid by a few whitish scales.

Beneath dark fuliginous brown, with a slight purplish tinge, the outer half, especially of the fore wings, paler. Fore wings with the vitreous spots exactly repeated, and the extra-mesial band faintly defined with independent spots, more noticeable in the subcostal area than elsewhere; the submarginal row of spots of the upper surface almost exactly repeated beneath, preceded and followed by pale or whitish clouds, less distinct and more extended within than without, below and along the inner margin bathing the whole in pale gray, and at the apex wholly supplanted by hoary or lilaceous flecking, which occupies the apex of the wing beyond the extra-mesial band, and continues next the outer border to the middle of the wing; the upper part of the cell is filled nearly to the tip with a dusky band; the outer margin is edged with black and the fringe is dark slate brown, a little pale at the extreme base. *Hind wings* with a submarginal series of very large, rounded, triangular, nearly equal, independent, blackish brown spots, their outer borders forming the base of the triangles, and placed at half an interspace's width or less from the margin; they extend from the costal to the submedian nervures, and are connected with the border by generally distinct, short, whitish lines in the middle of the interspaces; toward the base of the wing they are edged with pale or whitish crescents, more distinct and broadest next the base, and in the interspace beyond the cell a little removed from the spot itself; these are followed immediately by another transverse series of somewhat smaller, less distinct and less independent dusky spots, occupying the same interspaces, sinuous in direction, inasmuch as they recede from the border between the principal nervures and approach it between the nervules of the same system; a similar spot is found in the middle of the extremity of the cell, separated from that beyond by a faint, paler cloud. Outer margin and fringe as in the fore wing.

Abdomen blackish brown above, the segments tipped with dark cinereous; beneath grayish brown. *Upper organ of male appendages* (36:21-23) with the centrum long and slender, not elevated, unusually small; crest consisting of a pair of depressed, slightly curving, lateral expansions, nearly horizontal, the anterior angle produced as a small, narrow, rounded lobe, directed outward and slightly forward. Hooks short, moderately slender, slightly divergent, broadly separated at base, the main body at their extreme base expanding laterally in a ridge nearly or quite continuous with the lateral arms; tooth stout, conical, directed somewhat forward, terminating bluntly with a slightly elevated apical ridge. Lateral arms slender, directed at first forward

and slightly downward, then downward and slightly forward, finally bent abruptly at a right angle at the bottom, and continued backward to the inferior armature, which is borne upon its upward curved, slender limb, on either side of, and behind, the tooth. *Left clasp*: Main body increasing rapidly in breadth from the base to the commencement of the lobe; transversely it is curved a little, longitudinally it is almost straight. Blade of nearly uniform width, elbowed just before the middle in an upward direction, and at the same time bent at an angle of about forty-five degrees inward, the outer surface becoming uppermost, carrying with it the upper half of the basal portion of the blade; the apical third of the outer surface, and particularly the border and the broadly rounded, faintly uncinated tip, armed with minute spinules or raised points. A minute tubercle shows the position of the basal process. The region of the lobe is marked by a distinct furrow running far toward the base of the main body; the lobe is of medium size, bent a little inward, with a slight sinuosity, and is rudely triangular; the basal portion of its upper border is a little swollen, its apical half slightly arched and thickened. *Right clasp*: Main body similar to that of the left piece but slenderer. Blade compressed and tuberculate at the base of the lower edge, like that of the left clasp, but having the upper edge slightly thickened and bent inwards; it is broad at base, narrows slightly and regularly for three-fourths the distance to the apex, excepting a central, broad, scarcely elevated denticle on the upper edge; is there bent abruptly inwards and slightly upwards, then suddenly narrowed, and terminates in a bluntly rounded point; this narrowed portion is armed like the tip of the opposite blade; basal process wanting. Lobe broad at the base, narrowing immediately, suddenly and extremely, and then developed into a somewhat compressed polleiform process of nearly uniform size, parallel to the basal portion of the blade, about as long as its terminal portion, ending in a thickened, bluntly rounded tip.

Measurements in millimetres. Length of tongue, 10 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	15.5	16.25	17.	16.	16.5	17.5
antenna.....	8.	8.5	9.1	8.	8.4	8.8
hind tibiae and tarsi..	7.	7.25	7.5	7.5	7.5	8.15
fore tibiae and tarsi..	4.6	4.9	4.9	4.4	4.7	5.

Described from 17♂, 3♀.

Accessory sexual peculiarities. The costal fold of the fore wing of the male encloses a mass of clustered pediform bristles (47: 8c) about .75 mm. long; apple-seed androconia (8 a) closely packed on the costal vein; stout, straight, simple bristles (8 d) perhaps occasionally expanding and two-pronged at tip; and cover-scales (8 b) more than usually elongate.

Egg (66: 16). Shaped much as in the other species, but perhaps with the sides not so strongly curved, the ribs, eighteen or nineteen in number, being more than usually numerous, about 12 mm. apart, all nearly reaching the edge of the central summit depression but only ten actually doing so; this depression (69: 9) is .16 mm. in diameter, the innermost circle of eight micropyle canals, .01 mm. in diameter, which is about the length of the surrounding kite-shaped, micropyle cells, eight or nine in number, followed by hexagonal elongated cells which become larger and shorter as they recede from the centre; the space between the ribs crossed by scarcely perceptible raised lines, or distinct only next the vertical ribs, breaking the surface into cells about five times broader than long, the cross lines being about .23 mm. apart; surface of cells with regularly distributed, tolerably frequent, circular punctures, .002 mm. in diameter.

Caterpillar. Last stage (77: 13). Head dark brownish fuscous, each side with an upper and lower dull, yellowish, oval spot. Body pale pea green; (the figure is rather dubious but) apparently the dorsal surface is darker green than most of the body with some obscure longitudinal dashes of white in it; it is followed by rather high lateral bands of pale greenish yellow; there is also a similar stigmatal band, the space between being again greenish, delicately blotched with white; last segment yellowish; legs brownish

yellow; prolegs greenish. Length, 32 mm.; height, 5.5 mm. Described from Abbot's drawings.

Chrysalis (85:37). Pale pea green, paler still on the abdomen; cremaster yellowish orange, thoracic spiracle black. Length, 22 mm.; height, 5.5 mm. Described from Abbot's drawings.

Comparisons. This species differs from all the others in the intensity of the dark spots, which are free from white interior fleckings and vary in depth in different parts of the wings; besides they are more than usually well defined, giving the wing a checkered appearance quite peculiar to the species; the vitreous spots are very small and many of them frequently obsolete; its markings differ so much from those of all the others—more than any of them from one another—that it is difficult to say to which it is most closely allied in the markings; perhaps to *briseis*, but from this it can be immediately distinguished by the presence of vitreous spots; perhaps to *persius*, but the distinctness and blotchiness of its markings at once separates it; beneath it closely resembles *leclus*.

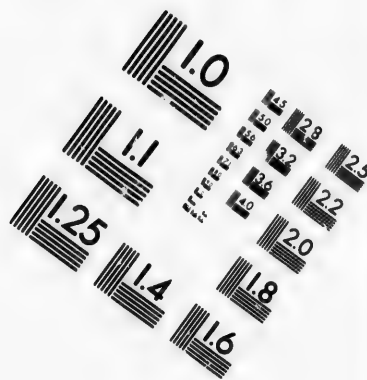
Distribution (28:5). This butterfly is a member of the Alleghanian and Carolinian faunas but does not seem to reach the extreme boundaries of either. In the north it has been found at Albany, N. Y., "abundant" (Lintner), London, Ontario (Saunders), northern Illinois (Worthington), Wisconsin (Hoy) and Iowa "abundant" (Allen), and in the south as far as South Carolina (Atkinson) and Georgia (Abbot). In the west it is reported from the places already mentioned and from Ohio (British Museum), Cumberland Gap, Ky. (Dimmock), Missouri (Edwards), eastern Kansas (Snow), Colorado (Morrison) and even New Mexico (Snow).

In New England it is by no means common but has not been taken north of Massachusetts; the northernmost localities recorded are Andover, one specimen (Scudder), South Hadley and Amherst (Sprague) and Amherst Notch, Mass. (Scudder); and the others, West Roxbury "two specimens" (Minot), Waltham abundant (Scudder), Tewksbury (Alcott) and Springfield, Mass. (Emery) and New Haven, Conn. (Mus. Yale Coll.).

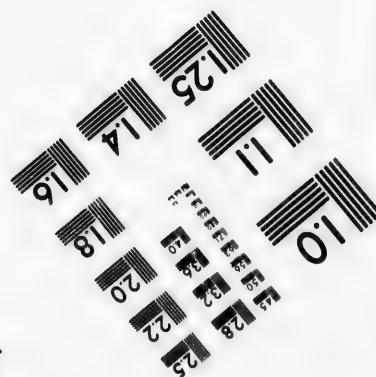
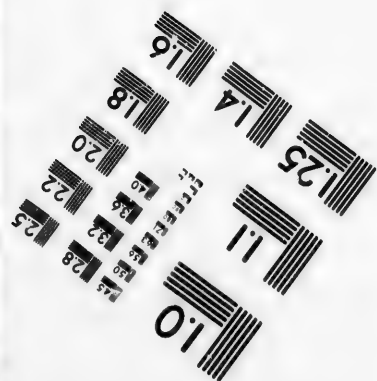
Food plants. Abbot states that the caterpillar feeds upon "red shank or red root"; Dr. Chapman is unable to suggest to what plant he may refer; *Ceanothus americanus* Linn. and *Lachnanthes tinctoria* Ell. go by this name in the north, but they are not very closely related to the known food plants of any species of this genus; the former, however, comes between the Malvaceae, on which a European species has been found, and the Leguminosae, upon which many species feed. In another manuscript Abbot adds to the others, "wild indigo," and the plant figured with the insect on the Boisduval drawings is *Indigofera caroliniana*, a very likely food plant, which must, however, be replaced by some other leguminous (?) plant at the north.

Life history. This butterfly is double brooded, presumably passing the winter as a full grown larva, as it appears in the spring with other species of the genus known to do so. The first butterflies appear just before the middle of May and continue to emerge from the chrysalis until the middle of June, but the first brood, which lasts even until the middle of





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July, never seems to become very abundant. Mr. Lintner has even taken one as late as July 28. In the south it appears as early as the beginning of March and the second brood from early in June to early in July, after 13 days spent in the chrysalis (Abbot). The second brood in the north appears about the middle of July and remains fresh throughout this month; occasionally fresh specimens may even be taken until the middle of August, and the butterfly remains on the wing until the early part of September. Lintner assures us that there are some color distinctions between the two broods, individuals of the later brood being more subdued in tone.

In the west the butterfly is found on the open prairie, with us it prefers wooded heights.

Desiderata. The early stages of this insect are practically unknown; since it is double brooded even at the north, it would be comparatively easy to rear in the localities where it is common if its food plant were found; the flight and postures of the butterfly are undescribed and no parasites are known. It will be interesting to compare its life history with that of the single brooded species.

LIST OF ILLUSTRATIONS.—*THANAOS MARTIALIS*.

<i>General.</i>		<i>Chrysalis.</i>	
Pl. 28, fig. 5.	Distribution in North America.	Pl. 85, fig. 37.	Chrysalis.
<i>Egg.</i>		<i>Imago.</i>	
Pl. 66, fig. 16.	Egg.	Pl. 9, fig. 12.	Male, both surfaces.
Pl. 69:9.	Micro-pyle.	36: 21-23.	Male abdominal appendages.
<i>Caterpillar.</i>		47: 8.	Scales of the male imago.
Pl. 77, fig. 13.	Mature caterpillar.		

THANAOS AUSONIUS.—The diminutive dusky wing.

Nisoniades ausonius Lintn., Ent. contr., 1: 34-36, pl. 7, figs. 11, 12 (1872);—French, Butt. East. U. S. 360-362 (1886). Figured by Glover, Ill. N. A. Lep., pl. T, fig. 4, ined.

Midsummer music in the grass,
The cricket and the grasshopper;
White daisies and red clover pass;
The caterpillar trails her fur
After the languid butterfly;
But green and spring-like is the sod
Where autumn's earliest lamps I spy,
The tapers of the goldenrod.

LUCY LARCOM.—*Goldenrod.*

Imago (15: 2). Head covered with slightly fulvous, mouse-brown hairs, mingled with lighter brown scales, the latter visible only where they edge the eye or on partial denudation of the top of the head; tuft of radiating hairs at base of antennae scarcely darker than those on summit and arranged in one vertical plane. Palpi furnished with a profusion of dark brown, occasionally pale-tipped hairs, mingled above with an abundance of gray scales, which are paler on the inner than the outer side of the palpus; terminal joint densely clothed with recumbent mouse-brown, slender scales. "Antennae red at tip, annulated with a clearer white than in the other species, having

the joints beneath almost entirely white." (Lintner.) Tongue blackish fuliginous at base, dark castaneous at extreme base.

Thorax covered above with more brown hairs, having a slight olivaceous tinge, mingled with some more recumbent purplish and tawny ones, and behind, on the sides, with some pale gray scales; beneath with rather paler, more brown hairs, mingled with grayer ones. Legs reddish brown; the femora covered on the inner side with golden gray scales, and both femora and tibiae fringed with long hairs of the same color as those of the under surface of the body; tarsi much darker above than elsewhere, pale yellowish below; spurs light castaneous at the tip, elsewhere clothed with gray-brown scales; spines castaneous; claws castaneous at the base, beyond, with the pad, infuscated.

Wings above with an umber-brown ground color. *Fore wings* with a very faint but warm mulberry tinge, arising from a very general flecking of hoary or pearly lilaceous scales over all parts of the wing but the darkest, scarcely any two of which touch each other, and which are most abundant on either side of the extra-mesal spots, especially above, and on the upper third of the basal half of the wing. The most conspicuous of the markings of the wing is the extra-mesal band of mingled black and dark brown scales, forming rather strongly curving, radiating fusiform patches in the interspaces above the lower outer edge of the cell, and a straight series of two larger roundish or quadrate spots in the lower median and medio-submedian interspaces, parallel to the outer border, and scarcely before the middle of the lower median nervule; the upper spots of the radiating series—those which are found in the superior subcostal interspaces—are much slenderer and somewhat longer than those below, and there are no hyaline spots in this region or elsewhere. Within this extra-mesal, slightly falciform band the wing is marked by several more or less regular, dusky or blackish dusky patches; thus the extremity of the cell is marked by a slender, curving bar, and just before it, within the cell, are a pair of dusky, subrectangular spots, the upper twice as large as the lower, and alone marked with black scales; the extreme base of the lower median interspace is marked by a minute, triangular, dusky spot, with scattered black scales, and a similarly marked subquadrate spot crosses the medio-submedian interspace midway between the extra-mesal band and base, which is itself more or less infuscated. Beyond the extra-mesal band the markings are confined to a premarginal series of very small, dark brown round spots, which are only distinct in the upper half of the wing, being merged more or less into a general duskiess of the margin on the lower half; the extreme margin is flecked with blackish scales, and the lower margin uniformly flecked with dark brown scales as far as the submedian nervule. Fringe made of mingled pale and fuliginous brown scales, with a few overlying pearly scales on the upper half of the wing. *Hind wings* of a duller and more obscure brown than the fore wings, infuscated on the basal third, with a transverse irregular series of small, pale spots, round spots with ill-defined margin, crossing the outer half of the wing, and accompanied on the inner side by an indistinct dusky spot of slightly larger size, which touches it, and on the outer side, but midway between it and the margin, by a similar dusky spot; the more distinct of these pale spots form two parallel straight rows, the upper as far above the lower as the outer edge of the lower from the margin, and both forming an angle of about 135° with the middle median nervule. Extreme outer margin and fringe as in the front wing, but the latter with no pearly scales above.

Beneath dark umber brown, pretty uniformly sprinkled with dark brown scales, as far as the extra-mesal band. *Fore wings* with the extra-mesal band of upper surface repeated, but distinctly and with crowded blackish scales only in the upper half of the wing. Outside of it the wing is heavily flecked with pale gray scales, forming ill-defined, rounded spots immediately following the extra-mesal spots, and more or less distinctly surrounding, at least externally, a transverse submarginal series of dark brown round spots, which decrease in size in passing upwards to mere dots; lower half of outer margin infuscated. Fringe uniform pale slate brown; at base slightly overlaid with very pale gray scales. *Hind wings* with a broad, irregular, submarginal series of hoary gray, almost whitish, elongated and angulate lunules, rather distantly enclos-

ing roundish, dusky brown, submarginal spots; the brighter, central parts of the lunules correspond to the spots of the upper surface; outer margin marked throughout by a very narrow fuscous band. Fringe as in the fore wings, but with a slight fulvous tinge, and with no pale scales.

Abdomen purplish-brown above, becoming duller brown apically, the incisures paler; beneath grayish brown. Although the specimen studied is a unique, I have been permitted by Mr. Lintner to remove the scales from one side of the extremity of the abdomen to get a view of the abdominal appendages (36:33). This permitted a good view of only the apical half of the right clasp and the tip of the left, the remainder being concealed within the chitinous covering of the terminal segments of the body. It is therefore only possible to describe the differences between it and *martialis* in the parts seen. As judged from the other points of its structure so here it is plain that its nearest affinities are with this species, for in these and in these alone the blade of both clasps is abruptly bent beyond the middle. The blade of the right clasp differs in its greater slenderness and prolongation; the denticle of the upper edge is larger and more prickly, so that the blade seems to narrow more abruptly beyond it, while the bent apex is more distinctly conical and pointed. The bent apical portion of the left clasp does not appear to differ from that of *martialis*. Length of fore wing, 13.5 mm. Described from one male.

The single specimen here described is the only one yet known, taken near Albany, N. Y., on May 12, 1871. The specimen credited by Edwards to West Virginia I have seen and find that it does not belong here, but to *T. martialis*. Strecker, however, credits it to the middle states, Ohio, Maryland and Virginia. Naturally it is our least known butterfly.

LIST OF ILLUSTRATIONS.—*THANAOUS AUSONIUS*.

Imago.

Pl. 15, fig. 2. Male, both surfaces.

Pl. 36, fig. 33. Male abdominal appendages.

GROUP IV (brizo).

Antennal club composed of eighteen joints; fore wings without subapical vitreous spots; male hind coxae and tibiae sometimes with, sometimes without, special appendances, as in Group I; costal fold of fore wings of male furnished with slender, flagellate or twisted androconia; upper organ of male abdominal appendages with an unarmed crest with slight, lateral expansions; terminal hooks consolidated, stout, the tooth very large; clasps with well armed blades, exceptionally short as compared with the body, the basal and median processes distinct, the latter armed. Eggs with fifteen or less vertical ribs. Larval food diverse, principally Leguminosae and Cupuliferae. A single brood in the northern United States.

SPECIES: *brizo*, *icelus*.

THANAOUS BRIZO.—The sleepy dusky wing.

[The lesser dingy skipper (Abbot); black skipper (Gosse); large bluish winged skipper (Maynard); sleepy dusky wing butterfly (Packard).]

Thanaos brizo Bois.-LeC., Lép. Amér. sept., pl. 66 (1833);—Harr., Ins. Inj. Veg., 3d ed., 309-310, fig. 132 (1862);—Scudd., Butt., 300, fig. 108 (1881);—Fern., Butt. Me., 104-105 (1884);—Mayn., Butt. N. Engl., 55, pl. 7, fig. 80, 80a (1886).

Nisoniades brizo Westw.-Hew., Gen. diurn. Lep., II: 520 (1852);—Morr., Syn. Lep.

N. Amer., 114 (1862);—Park., Can. ent., III: 113 (1871);—Scudd.-Burg., Proc. Bost. soc. nat. hist., xlii: 289-290, pl., fig. 4 l, r, u (1870);—Lintn., Ent. contr., I: 31, pl. 7, figs. 9-10 (1872);—iv: 64-65 (1878);—H. Edw., Stand. nat. hist., II: 474, fig. 601 (1884);—French, Butt. east. U. S., 334-356 (1886).

Thymele brizo Gosse, Can. nat., 183 (1840).

Erynnis brizo Scudd., Syst. rev. Am. butt., 51 (1872).

Papilio juvenalis Smith-Abb., Lep. ins. Geo., tab. 21, fig. sup.; not text (1797).

Papilio — Abb., Draw. ins. Geo. Br. mus., vl: 74, figs. 99-101; xvi: 49, tab. 175 (ca. 1800).

? *Achlyodes gesta* Herr.-Schaeff., Schmiett.

Cuba, 16 (1865).

? *Nisoniades gesta* Gundl., Ent. cub., 1: 145 (1882).

Figured also by Abbot, Draw. ins. Ga., Oemler coll., Bost. soc. nat. hist., 30;—Glov., Ill. N. A. Lep., pl. 29, figs. 4, 8; pl. B, fig. 12; pl. T, fig. 10, lined.

See there! the waving butterfly,
With starting motion fluttering by,
From leaf to leaf, from spray to spray,
A thing whose life is holiday.

MARY HOWITT.—*Spring*.

Imago (9: 3, 9; 13: 17). Head covered with nearly uniform, dark brown hairs, occasionally tinged with purple; the scales which encircle the posterior half of the eye are scarcely paler, except in a minute dot behind the antennae; tuft outside of antennae black. Palpi beneath gray brown; grayest near the base, beyond slightly tinged with purple and often minutely pale-tipped; above, and to some extent outside, where longer black hairs are intermingled, darker; apical joint dark brown, slightly paler beneath. Antennae purplish black, the stalk narrowly annulated with white at the base of each joint, often interrupted or indistinct above on the basal half; beneath, posteriorly, wholly white, flecked with dusky at the apices of the joints, and on the club forming an uninterrupted patch of white, grayish or yellowish toward the borders; beneath, anteriorly, the club is naked and blackish, scarcely tinged with castaneous on the apical joint.* Tongue piceous, the extremity dull castaneous.

Thorax covered with dark brown, sometimes blackish, hairs above and below. Legs nearly uniform dark purplish brown; the tarsi sometimes a little paler, and the whole more or less flecked with slightly paler grayish scales, especially on the inner surface; spurs dark brown, paler beneath, tipped with dark reddish; spines dull reddish luteous; claws reddish luteous at base, blackish toward tip; pad blackish.

Wings above very dark, grayish brown, scarcely tinged with fuliginous or mulberry, the ♂ generally grayer, especially on the fore wing, in old individuals often almost wholly cinereous. Fore wings almost uniformly, but not very heavily flecked on the upper half of the wing with short white hairs and elongate white scales, occasionally a little lilaceous; descending, also, upon the lower half in diminishing numbers along the outer margin, and also occupying all but the edges of the spots forming the transverse bands, where they are generally more tinged with lilaceous than elsewhere; between the extra- and intra-mesial bands they are never (or if ever, in the slightest possible degree) more distinct or frequent than at the apex of the wing. An obscure, scarcely distinguishable patch, scarcely darker than the ground color, is found at the extreme base, and generally follows along the subcostal nervure to the dark intra-mesial band; the exterior limits of the latter can usually be traced across the wing, and not infrequently its interior limits also, especially in the ♀; it forms a nearly equal, moderately broad sinuous band, expanding a very little at its extremities, extending from the subcostal nervure, its outer limit just below the tip of the costal fold of the male to the middle of the basal two-thirds of the submedian nervure; when most complete, both its borders, but especially the exterior, have a tremulous outline, and its breadth is similar to that of the extra-mesial band; the lower half is not infrequently subobsolete, and usually the interior is not so heavily flecked with whitish scales as the next band. The extra-mesial dark band is always rather distinct, pretty regularly arcuate, equal, its average breadth a little greater than the width of the lower median interspace, very nearly parallel to the outer border, and extends from the

* The form of the club in this species varies considerably from the typical form seen in the other members of the genus, approaching

somewhat that of the neighboring genera *Pholisora* and *Hesperia*,—particularly in the brevity and bluntness of the apical portion.

costal margin, midway between the tip of the costal fold of the ♂ and the tip of the wing, to the middle of the outer two-thirds of the submedian nervure; the spots of which it is formed, and which are closely connected to form a band (more so than in any other species) are pretty heavily and uniformly flecked interiorly with white scales, tending toward lilaceous, leaving only the exterior and interior margins black; the interior border of the band is thus formed of a series of nearly straight, short, nearly continuous, black transverse dashes; the exterior of similar but more or less arrow-shaped spots, pointing outward, and often edged, especially toward their tips, with grayish flecking. The submarginal series of spots is never distinct, not infrequently wholly obsolete, and when present usually consist of small, roundish spots, increasing in size in departing from the costal margin, and only noticeable from the absence of pale flecking, so that, as the flecking ceases in the lower half of the wing, they grow more and more inconspicuous, often only their outer edges to be detected; occasionally they are darker than the ground color, and occasionally followed apically by faint grayish, minute spots, or lines leading to the margin. The outer margin is edged with black, often partially obscured or interrupted by the pale fleckings, which extend, also, upon the basal third of the fringe, which otherwise is nearly uniform and composed of mingled scales, most of the ground color of the wing, others paler. *Hind wings* uniform, of the ground color of the fore wings; the only markings are two rows of small, dull, brownish yellow spots, either minute, or very dull and indistinct, often very nearly obsolete in the ♂, larger, brighter and pretty distinct in the ♀, one marginal, the other sinuous, crossing the outer two-fifths of the wing; outer margin edged with black, rather more broadly than on the fore wings; fringe of much the ground color of the wing, often darker than it basally, and occasionally paler toward the tip.

Beneath dark, often blackish, fuliginous brown, the hind wing sometimes darker than the fore wing, which generally has something of a grayish tint and is slightly paler—tinged with dull ochraceous—toward the inner border. *Fore wings* having almost always and distinctly (♀), or generally, but usually obsolescent (♂), an arcuate row of quadrate, pale, equal spots parallel to the outer border, in the position occupied by the vitreous spots in other species; they are faintly tipped externally with dusky and then followed by an arcuate series of usually very faint, longitudinal, independent, pale streaks reaching as far down as the submedian, often obsolete in the ♂; the upper ones are often obliterated by a light flecking of hoary scales at the tip of the wing beyond the pseudovitreous spots; next the margin is a series of small pale spots in the interspaces; outer border edged with black. Fringe of the ground color of the wing, often lightly flecked at the extreme base with whitish. *Hind wings* with a marginal series of spots similar to those of the fore wings but larger and often more intense along a longitudinal median streak; and in the middle of the outer two-fifths of the wing is a transverse series of similar spots often a little larger and usually subtriangular, parallel to the outer border excepting in the interspaces beyond the cell, where they often form oblique streaks placed at a slight angle with each other and much further from the outer border than the other spots, the upper being midway between the basal divarication of the subcostal nervure and the outer border; all these spots are a little heavier and more distinct in the ♀ than in the ♂; occasionally in the ♀ there is a pale spot at the extremity of the cell, but no dark markings accompany the extra-mesal band excepting occasionally very faint ones in the ♀. Outer border and fringe much as in the fore wings, but the base of the latter not so pale.

Abdomen very dark brown above, the tip with a few dark ochraceous, elongate scales; beneath more or less flecked with grayish. *Upper organ* of male appendages (36: 7-12) having the centrum moderately slender, long and high, strongly arched; from the middle of the extreme posterior slope of the upper surface, a lateral, triangular, slightly curved plate or alation with rounded apex, arises on either side, projecting outward and a little upward, the anterior edge nearly at right angles with the median line of the main body, or even directed a little forward, and a little elevated. Hooks united into one extremely large beak, swollen beyond the middle, the tip pointed, the sides at base compressed and directed downward as small flaps; beyond the middle

of the lower surface depends a very large, appressed tooth, the anterior edge nearly straight, the posterior curved sinuously forward, as seen from the side broad and well rounded, the posterior surface having the edge emarginate, and furnished with a slight median ridge. Lateral arms extremely broad at origin, tapering very rapidly in a downward direction, becoming slender before the lowest point is reached, and then remaining of nearly the same size; below bent squarely at right angles backward, pursuing a straight horizontal course for half the distance to the tip, then curving inward and upward, expanding a little at the united tips, and bearing the inferior armature of minute raised points—not very distant from the pads at the base of the terminal hooks. *Left clasp*: Main body large and gibbous, its base slender, broadening pretty regularly, nearly straight in projection. Blade broad at base, narrowing rather rapidly in the basal half, beyond pretty uniform, the tip rounded and thickened, but obliquely docked; basal process directed horizontally backward, bent or curved at base inwardly, twisted very slightly, with a tendency to bring the inner side uppermost; the whole upper edge is armed with minute recurved denticulations, extending as far as the tip, and on the apical third forming a double row of minuter teeth; the basal process is a rather small rounded lobe, whose general direction is upward at right angles to the blade, curving a little inward, and having one edge a little concealed by the minute hind process of the lobe; its whole outer edge is covered by recurved denticulations, in continuation of those on the blade; the terminal portion of the outer surface is also minutely spinulate. Upper process of lobe directed upward, curved inward and thickened a little above, its edge showing indications of obsolete denticulations. *Right clasp*: Main body similar to that of the opposite side, excepting that it is much broader at the base—nearly as broad as anywhere. Blade short, about half as long as the opposite clasp, broad, compressed, the basal half narrowing somewhat, the tip rounded and scarcely excised, the armature as on the opposite clasp; basal process similar to the opposite, but smaller and twisted, so that its inner surface is directed backward and a little inward, and this face, instead of the outer, is furnished with spinules; the border is armed as in the opposite piece, but the basal border is free from, although concealed by, the lobe. Each of the processes of the lobe is simple and broadly rounded, the hinder scarcely the larger.

Measurements in millimetres. Length of tongue, 10.25 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	17.35	18.	20.	16.5	18.5	21.5
antennae.....	8.4	9.15	10.5	8.	9.	10.5
hind tibiae and tarsi..	6.8	7.9	8.7	6.7	7.75	8.4
fore tibiae and tarsi..	4.5	4.9	6.	4.2	4.6	5.25

Described from 36 ♀, 13 ♂.

Accessory sexual peculiarities. The costal fold of the fore wing of the male (45: 2-3) is mainly filled with a dense mass of amber-colored, rod-like bristles (47: 7e), largest near the base and delicately tapering, about .18 mm. long, seated on the costal vein, sometimes erect and sometimes recumbent; while actually homologous to the apple-seed or scaphiform androconia of the preceding species, they are greatly elongated and appear to function for the pediform bristles which are wholly wanting; the basement field below the costal vein is filled with similar but much shorter amber-colored bristles (7 d), which are apparently more flexible; there are besides many stiff and slender, horny bristles (7 f) which are about 5 mm. long; and a very few slender and rather short chain-bristles, or perhaps more properly twisted ribbons (7 a) next the lower edge; cover-scales (7 b, c) of varying sizes and shapes occur at the two edges.

Egg (66: 12). Fifteen longitudinal ribs, .17 mm. apart, pretty straight, thin, uniform, rather sharp, the very edge rounded, raised above the lowest portion of the space between them .025 mm. Cross lines very delicate, crossing the ribs, .025 mm. apart; surface very delicately shagreened with multitudinous, excessively minute raised points. Micropyle rosette (69: 4) .127 in diameter, the lines bounding the cells

slightly elevated, not very delicate; central circle .0126 mm. in diameter; cells succeeding it .021 mm. by .017 mm., outermost longest cells about .03 in diameter. Height, .74 mm.; greatest breadth, .79 mm.; breadth at a distance of .13 mm. from the top, .66 mm.; height, .74 mm.

Caterpillar. *First stage.* Head orbicular, slightly flattened above, as broad as middle of the body; uniform pale yellow with a brownish tinge, with white hairs; ocelli black; labrum, labium and antennae pale; mandibles of the color of the head at base, the edge dark castaneous. Body pale greenish yellow, with a brownish tinge, fainter than that of the head; skin distinctly shagreened; dorsal shield of the first thoracic segment scarcely darker than the body, not so dark as the head. Legs and prolegs concolorous with the body, the claws of the former pale castaneous; bristles pellucid, of exceptional length, so that the abruptly expanded apex on those adjoining nearly touch; those of the suprastigmatal series are .025 mm. long and of similar breadth at the top; those of the infrastigmatal series are .75 mm. long and only slightly expanded at tip, to a width of about .01 mm. Length of body, 3 mm.; breadth, .4 mm.

Last stage (77: 12, 18) Head dark brown, paler yellowish brown above. Body rather pale green, with a dark green dorsal stripe, bordered with pale greenish yellow, a rather narrow stigmatal band of pale greenish yellow, and between the two and below the latter, rather pale green flecked with darker green dots; last segment pale yellowish green. Prolegs of color of body; legs greenish, tipped with brownish yellow. From Abbot's drawings in the Boisduval library.

The figure in the British Museum drawings by Abbot gives an orange-yellow spot on either side of the base of the frontal triangle, and the body pale yellowish brown, with a darker dorsal band and a pale, rather indistinct lateral band; segments dotted obscurely with fuscous on their posterior half, but not on the bands just mentioned. Length, 31 mm.; height, 5.75 mm.

Specimens which I had upon oak were presumed to be *T. juvenalis*, and no description of them taken.

Chrysalis (85: 38). Pea green, paler on abdomen, the terminal third of the segments of which are again a little darker. Thoracic spiracle black; cremaster inclining to yellowish brown. From the Boisduval series of Abbot's drawings.

The very poor drawing in the British Museum series gives it as reddish brown, darker on the thorax and wings than on the abdomen. Length, 22.5 mm.; height, 5.25 mm.

The chrysalis skin, after escape of the butterfly, differs strikingly by its darker color from that of *T. lucilius*. It is almost completely luteo-castaneous, the wing cases and all the appendages blackish fuliginous, as is also to a large extent the whole head and thorax; these and the base of the wings as well, are vaguely blotched with olivaceous. The sutures both of thorax and abdomen are marked with salmon color, and the prothoracic spiracle is velvety black. The whole surface is smooth and glistening, feebly striate transversely, almost absolutely without hairs, these being excessively short, scattered widely, situated in the larger punctae. Length, 13 mm.; breadth, 4.25 mm.

Comparisons. This species differs from *icelus* in its almost invariably considerably larger size, in the greater distinctness and limitation of the intra-mesial band, in having the upper half of the wing beyond the extra-mesial band quite as distinctly flecked with hoary as the same part of the wing between the two mesial bands, while in *icelus* the latter is invariably conspicuous in fresh specimens; it also differs in the contrast the ♀ presents to the ♂, it being more grayish.

Distribution (28: 4). This butterfly is very widely distributed; it crosses not only the Canadian and Alleghanian faunas but also the Carolinian, though its western extension is very imperfectly known. The northernmost known stations are Nova Scotia "very abundant" (Jones), Quebec "common"

(Bowles, Fyles), Montreal, rare (Caulfield), Ottawa (Billings), London, Ontario "rather common" (Saunders), and southern Michigan "not common" (Harrington). Jenner Weir even states that three specimens were taken by Haydon at Moose, James bay, and I have colored the map accordingly, but I am strongly of the opinion that *T. icelus* has in this instance (as is not rarely the case) been mistaken for the present species. It is reported in the Carolinian fauna from West Virginia (Edwards), South Carolina (Atkinson), Georgia (Brit. Mus. and Abbot) and Florida (Norton), where it occurs as far as Haulover (Schwarz). It is also found in Dallas, Tex. (Boll). In the west it is recorded from Ames, Iowa (Osborn), eastern Kansas rare (Snow), Colorado (Lintner), Arizona (Edwards) and I have seen specimens from California (H. Edwards), and since the map was printed, Mr. Fletcher tells me it occurs in Vancouver Island.

In New England it is widely spread but has not yet been found at the White Mountains, although Professor Hamlin has discovered it at Waterville, Me., it is "occasional" at Milford (Whitney) and has been found at Thornton and Dublin, N. H. (Faxon), while about Boston and in the Connecticut valley south of Amherst it has been obtained by many collectors. Mr. Fish has taken it on Cape Cod. It is not so common as most of the other species.

Food plants. Abbot makes the same statement of this as of other species—that the larva feeds on "wild indigo," etc. Dr. Chapman suggested that this might be a *Baptisia*, but in this instance the plant figured has been identified as *Galactia glabella*, and it may be that in other instances where Abbot speaks of "indigo" he may refer to *Galactia*. Abbot also states that it feeds on oaks. I tried a newly hatched larva upon red oak but it refused to eat it, but on the other hand caterpillars which I had taken in the autumn on *Quercus ilicifolia* and kept over winter produced this butterfly. A figure of Abbot's I formerly regarded as probably referring to *brizo*, but which seems to be more probably *martialis*, was said to feed on beggar's lice and consequently *Cynoglossum morrisoni* has been quoted as the food of the present species, but probably by mistake. I once enclosed a female over *Thermopsis caroliniana* but failed to get eggs.

Haunts and habits of butterfly. The butterfly frequents moist shady spots and forest openings and is difficult to capture, flying swiftly with frequent, sudden movements from one side to the other, but always remaining about three feet above the ground. The female is very fond of violet blossoms. Jones says it frequents the blossoms of blueberry.

Life history and seasons. This insect is evidently double brooded in the south, as Abbot bred specimens March 22, April 21, and August 5, the last from a chrysalid which had been hanging for nine days. Harris, perhaps following Abbot, also says that it appears in May and August, but no other observers, excepting some in the northern limits of its

range, have mentioned it later than June; whence it would appear that it is single brooded in the north. It appears on the wing very early in May, being nearly or quite as early as *T. persius* and Miss Guild even records taking it on April 27 at Walpole, Mass. It generally becomes abundant by the 10th of this month and undoubtedly continues to emerge from the chrysalis until the end of the third week and remains on the wing until the middle of June or later, and in northern localities, such as northern New England, until near the middle of July. The eggs are probably laid by the middle of May; they hatch in less than nine days and the caterpillar when full fed prepares for the winter, which it passes in this condition, changing to chrysalis early in the spring.

I once carried a pair through the winter, one in the cold-storage warehouse in Boston, where the thermometer was kept at a uniform temperature of about 35°; it was brought out on May 23d and kept at first in a cool place but two days later into an ordinary unheated room; it went into chrysalis about June 7, and emerged June 20; the other was wintered in the cellar and it went into chrysalis about June 2, but gave out a parasite.

Parasites. The above is the only instance known, the parasite being dipterous, *Exorista blanda* var. *proserpina*. It made its mahogany puparium June 11 and emerged June 25.

Desiderata. Considering that Abbot painted figures of the caterpillar and chrysalis of this insect nearly a century ago, and that it is a common butterfly over a very wide territory, it is not creditable that we know scarcely more about it than what Abbot has given us. The early stages are quite insufficiently known, the food plants of the caterpillar to some extent doubtful, its habits undescribed as well as those of the butterfly. No hymenopterous parasites are known and the distribution of the insect in its northern and western range is very uncertain. Is it an insect of the low country, that though found from Atlantic to Pacific it has so rarely been noted in the elevated plateau region? Is there ever a second brood in the north? Is there always one at the south?

LIST OF ILLUSTRATIONS. — *THANAOS BRIZO*.

- | <i>General.</i> | | <i>Imago.</i> |
|--|--------------------------------------|---------------|
| Pl. 28, fig. 4. Distribution in North America. | Pl. 9, fig. 3. Male, both surfaces. | |
| | ♀. Female, upper surface. | |
| Pl. 66, fig. 12. Egg. | 13: 17. Both surfaces. | |
| 69: 4. Micropyle. | 36: 7-12. Male abdominal appendages. | |
| <i>Caterpillar.</i> | 45: 2. Cross section of costal fold. | |
| Pl. 77, figs. 12, 18. Mature caterpillar. | 3. The same, opened. | |
| <i>Chrysalis.</i> | 47: 7. Scales of the male imago. | |
| Pl. 85, fig. 38. Chrysalis. | | |

THANAOS ICELUS.—The dreamy dusky wing.

[Least dingy skipper (Abbot); small bluish banded skipper (Maynard).]

Nisoniades icelus Lintn., MS., Scudd.-Burg., Proc. Bost. soc. nat. hist., xiii: 288-289, fig. 3 l, r, u (1870);—Park., Can. ent., iii: 113 (1871);—Lintn., Ent. contr., i: 30-32, pl. 7, figs. 5-6 (1872); Pap., i: 72 (1881); Rep. ent. N. Y., i: 335-336 (1882);—Edw., Can. ent., xvii: 98-100 (1885);—French, Butt. east. U. S., 355-356 (1885).
Erynnis icelus Scudd., Syst. rev. Am. butt., 51 (1872).

Thanaos icelus Fern., Butt. Mo., 105 (1884);—Mayn., Butt. N. E., 54-55, pl. 7, figs. 79, 70a (1886).

Cartrocephalus mandan Mayn., Butt. N. E., pl. 8, figs. 85, 85 a [not the text] (1886).
Nisoniades hamamaelidis Fitch, MS.

Figured by Glover, Ill. N. A. Lep., pl. T. fig. 5, lued.

God's Butterfly on our love's flower alight!

It seemeth the beautiful thing,
At the first sunrise of the heaven she hath left,
For the winterless world will wing.

GERALD MASSEY.—*The Mother's Idol Broken.*

Imago (9: 6). Head covered with dark, slightly purplish brown hairs, mingled with a few grayish brown ones; a narrow line of pale grayish brown scales edges the eye behind and above; tuft outside of the antennae black. Palpi furnished beneath with pale gray brown scales, occasionally paler at their tips, outside with a few and above with many dark brown scales; longer black hairs are also found in some abundance outside and beneath; the terminal joint is nearly uniform dark brown, scarcely lighter beneath, more heavily clothed than in the species hitherto described. Antennae blackish with a purple tinge, beneath the basal half of the joints wholly white and the apical half largely flecked with white so as to give a hoary appearance, or, especially toward the distal end, white with yellowish white fleckings and covering the inferior surface of the club with a uniform field of silvery white, sometimes flecked especially toward its borders with yellowish brown; anteriorly, on the stalk, the white extends along the basal fourth of the joints forming distinct spots and above very narrow pale or white annulations at the extreme base; anteriorly the club is black, sometimes velvety black, but toward the tip it becomes tinged with castaneous, especially at the edges, and the apical joint is wholly naked and castaneous. Tongue pitchy black, the tip testaceous.

Thorax covered above with dark brown, slightly gray flecked hairs; beneath with slightly paler, mingled with pale gray hairs. Legs dark brown slightly tinged with purplish on the tibiae and darker at the apex of the tarsal joints than at the base; more or less gray-flecked beneath as far as the middle of the tarsi. Spurs brown flecked with gray, reddish apically, minutely tipped with black; spines dark reddish luteous; claws the same at the base, beyond dusky, pad dusky.

Wings above very dark grayish-brown, scarcely tinged with fuliginous or mulberry. Fore wings considerably flecked, especially on the outer half of the wing and along the nervures with lilaceous scales; these are most conspicuous in the upper half of the wing between the extra- and intra-mesial bands, within the spots of the extra-mesial band and narrowly on either side of the black edging of the outer border, as well as between the extra-mesial and submarginal series of spots, especially in the upper half of the wing; less abundantly they are found in the upper portion of the intra-mesial band, and scattered infrequently toward the base of the wing and along the inner margin, especially in the outer half of the wing; the basal third of the wing is so clouded with confused dark patches that one can distinguish but seldom any interior limit to the intra-mesial band; the exterior margin runs from the tip of the costal nervure in a slight curve, its convexity outward, to the lowest median nervule, close to its base, and then crosses the interspace below at right angles, starting from the median nervure, just before its first divarication. The extra-mesial band is more distinct, its exterior and

interior margins being about equally well, although not sharply, defined; it is of nearly equal width, slightly arcuate, parallel to the outer border, and like that slightly disturbed in its regularity just below the middle, sometimes it is simply bent, but quite as often the lower half is removed very slightly inward and curves in an opposite sense, making the whole band slightly sinuous; it extends from the costal margin, midway between the tip of the costal nervure and the tip of the wing to the middle of the outer three-fifths of the submedian nervure, and is about equal in width to the breadth of the medio-submedian interspace; the connected spots of which the band is formed are almost always lighter than the blackish edges, and are still more greatly contrasted by the hoary flecking of the interior; the interior edge of the band is simply a tremulous line, while the exterior is a strongly, often deeply and sharply zigzag line, the spots being spear-shaped exteriorly, though more generally blunt than pointed; they are usually followed by more or less distinct grayish fleckings; the submarginal series of often connected spots is slightly further removed from the outer margin below than above; the spots vary in size according to the individual, usually increase in size downwards, when independent are usually round, approaching a lunulate form as they merge, and generally preserve this tendency when most completely transformed to a band. The outer margin is edged with blackish and often crossed by short longitudinal lines on the tips of the nervures, especially in the lower half of the wing, which extend an equal distance on either side of it, and reach nearly to the middle of the fringe. Fringe dark brownish fuscous; the basal two-fifths blackish, but almost entirely concealed by lilaceous fleckings. *Hind wings* quite uniform in tint, exactly of the real ground color of the fore wings, or occasionally slightly darker; two rows of moderately distinct, but generally not well defined, small, roundish, yellowish brown spots are found on the apical portion of the wing; one is a regular marginal series, usually of pale points or dots in all the interspaces, the other less regular, sinuous, at least in the upper half of the wing lying in the middle of the outer four-fifths of the wing, and composed of larger spots sometimes partially obsolete; a similar spot often occurs near the apex of the cell; outer margin edged, sometimes obscurely, with blackish; fringe a little paler, more yellowish brown than on the fore wing, the basal portion infuscated.

Beneath very dark brown, scarcely tinged with purplish, a little grayish, especially on the outer half of the fore wings. *Fore wings* with more or less distinct pale spots, generally quite distinct and pretty large in the ♀, where the vitreous spots of the other species occur, and almost always, also, in the interspaces beyond the cell; all these, and especially the subcostal ones, are edged externally with blackish, and these again followed usually by an arcuate series of longitudinally ovate, independent, equal, very pale ochraceous spots in the middle of the apical half or two-fifths of the wing, but are often obliterated above by a large patch of hoary, slightly lilaceous scales, which occupies the apex of the wing beyond the dark bordering of the pseudo-vitreous spots; a marginal series of minute pale or whitish spots or dots occur in the interspaces. Outer border edged with black. Fringe nearly uniform, dark slate brown, often flecked with pale or whitish scales at the extreme base, especially above. *Hind wings* with a distinct marginal row of small, pale ochraceous spots, always more intense along a longitudinally median line, and sometimes reduced to this streak; a sometimes equally distinct, transverse series of similar but roundish or subtriangular spots in the middle of the outer two-fifths of the wing, parallel to the outer border, excepting that in the interspaces beyond the cell the spots recede to a point midway between the base of the first subcostal nervule and the outer border, and, in the costo-subcostal interspace, the spot is usually even further from the border; these spots are all followed interiorly by darker spots, very nearly obsolete, sometimes only forming a dark interior edging to the pale spots, but generally of equal size, dusky and indistinct, of a roundish form; in the middle of the extremity of the cell is a similar but generally more indistinct, pale spot, followed interiorly by a dusky one; outer border and fringe much as in the fore wings.

Abdomen blackish brown above, often faintly flecked with grayish at the extreme

tip of the segments, grayish brown beneath. *Upper organ of male appendages* (36:30-32) with the centrum short, pretty high, not very slender. Dorsal crest consisting of a pair of very small, horizontal, lateral alations, the posterior angle of each rounded, the anterior produced laterally as a bluntly pointed triangle. Hooks forming a single, stout, slightly curving, pointed beak, directed backward, bearing beneath, just beyond the middle, an appressed, dentiform, backward curving appendage, which is provided, on the outer edges of its apex, with a pair of short, stout, divaricate thorns; on either side of the extreme base of the hook, its upper surface expands laterally to a very slight degree; and from the extreme base of its lower outer surface an appressed, conical tooth projects downward and slightly outward. Lateral arms broad at base, narrowing rapidly, directed downward and at the bottom bent at nearly right angles backward; they then curve backward, inward and upward, broadening slightly until they meet at some distance below the hook, bearing, on the whole of the outer lower surface of the curving portion, the inferior armature of rather distant, comparatively large, short, blunt spines, largest at the most posterior point. *Left clasp*: Main body very broad, increasing slightly in breadth from the base half way to the tip, nearly flat and straight, the upper edge produced and curved inward a little near the base, the lower edge a little full near the base. Blade straight, its lower edge continuous with the lower edge of the main body, slender, uniform, slightly compressed, not very long, armed at the apical half with minute, raised points, and terminating in a rounded point; basal process as broad as long, rounded, compressed, its hinder two-thirds bent at right angles inwards and a little upwards, and armed along its whole edge and a portion of its upper surface with minute spinules. Lobe rounded, deeply and roundly excised on either side, of about the size of the basal process of the blade, but smooth; just in advance of it the upper edge of the main body is slightly prominent. *Right clasp*: Main body similar to that of opposite side. Blade of the same length as that of the left clasp and otherwise similar, but curving very slightly inward and terminating in an unarmed, slightly rounded point, a very little angulated at the tip; basal process developed as a dactylate apophysis, directed upward, nearly at right angles to the blade, compressed, but twisted at right angles, so as to appear depressed, a little broader than the blade, shorter by nearly one-half, its tip broadly and regularly rounded, and armed with minute spinules. Lobe developed as a bluntly rounded, rather prominent plate in the middle of the upper half of the whole piece.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 8 mm.						
Length of fore wing.....	18.5	15.5	17.	11.55	16.25	17.5
antennae.....	8.5	9.	9.55	8.5	9.1	9.6
hind tibiae and tarsi..	6.2	7.		6.8	7.15	7.3
fore tibiae and tarsi...	4.45	5.		4.8	4.75	5.

Described from 39♂, 7♀.

Accessory sexual peculiarities. The costal fold of the fore wings of the male shows, seated on the marginal vein, a crowded imbricated mass of pallid, long oval scales (47:6 e) followed by an open field planted in a relatively sparse manner with little bilobed triangular androconia (6 b); and this by a dense field of erect, slender, parallel sided scales, slightly enlarged and trilobed apically, all the lobes rounded (6 c); these last conceal between them the triangularly lanceolate, slender, flagellate androconia (6 d), only the flagella appearing above the mass; large ovate cover scales, generally asymmetrical (6 a, f), complete the series.

Egg. Very pale green, of equal height and breadth, broadly rounded and even truncate at the base, broadest next the base, gently narrowing above, broadly rounded and slightly shouldered above, the central space between the terminations of the ribs saucer-shaped and considerably sunken, the central micropyle still further depressed. Sides with from ten to fourteen ribs, of which eight reach the summit, most of the others stopping just short of the saucer; they are strongly compressed, tolerably

high, .08 mm. in height, slightly higher above than elsewhere. Space between ribs strongly concave and filled with straight, equidistant, transverse raised lines, only .017 mm. apart, the floor of the cells thus made, delicately punctate. The saucer-shaped depression of the summit is .18 mm. in diameter, filled with nearly uniform, polygonal, coarse-walled cells, about .01 mm. in diameter, in the centre of which the micropyllic cells occupy a circle .02 mm. in diameter. Height, .85 mm.

Caterpillar. *First stage.* Head dull piceous, finely shagreened, with pellucid hairs. Body pale lemon yellow, the appendages pellucid, not over a fourth as long as the segments. Legs and prolegs concolorous. Length, 2.75 mm.

Second stage. Head dull piceous, more or less shagreened, and with pale hairs. Body pale green, made more or less hoary by the numerous, transversely arranged, pallid papillae on each section of the segments, each giving rise to a very short, pallid hair, apparently not half so long as one of the sections, and expanded at tip; a few are so arranged longitudinally on successive segments as to cause a delicate infra-lateral or latero-stigmatal line; posterior third of the body with a yellowish and slightly dusky tinge, and the same but not dusky is found faintly along the substigmatal fold. Spiracles apparently testaceous; legs a little infuscated, the claws dusky; prolegs concolorous. Length, 5 mm.; breadth of head, .65 mm.; of body, .65 mm.

Third stage. Head piceous, well but delicately corrugated, the hairs gray. Body as in preceding stage. Length, 6.5 mm.; width of head, 1.1 mm.

Fourth stage. Head as before. Body rather pale bluish green, dotted with delicate, infundibuliform, pale yellowish hairs on minute papillae, giving the whole a gray-green appearance with a faint, blue, dorsal stripe; and in addition there now appears, what at least had not been noticed before, a laterodorsal anterior series of minute, glistening, dark green lenticles, a little larger than the papillae, on the second thoracic to the ninth abdominal segments; there is also now a distinct, pale yellow, lateral stripe fading out on the thoracic segments and on the ninth abdominal segment, where it is well above the edge of the posterior flap; terminal segments somewhat discolored as if diseased. Length, 10.5 mm.; width of head, 1.5 mm.

Last stage (77:1). Head uniform light red-brown, the surface granulated and covered with fine down; ocelli red-brown on a black stripe. Body obese, largest in the middle, tapering about equally toward either extremity; first thoracic segment yellow, the shield concolorous; other segments gray green, caused by fine whitish granulations on a pale green surface; the dorsal region with a yellowish tint; a dark dorsal line over the abdominal segments, and a pallid lateral stripe with no further markings. Length, 18.3 mm.; greatest breadth, 4.6 mm. (After Edwards.)

Fitch thus describes the caterpillar he found on witch-hazel: Head dirty white, its base all around blackish, the vertex with a slight wide notch; jaws black. Thick-bodied, broadest in the middle, very pale green with innumerable white dots, a slightly deeper green dorsal line, and on each side of the back a whitish line; whole surface with fine, short, white hairs, .75 mm. long.

Chrysalis (85:27). Color of head case reddish brown, of wing cases less red, more brown, with a greenish tint; of mesonotum more yellowish; of abdomen pale flesh color; surface smooth, covered by a fine short down with scattered short hairs at anterior extremity. Length, 13.5 mm.; breadth at mesothorax, 3.6 mm.; of abdomen, 4 mm. (After Edwards.)

The following is Fitch's description of the pupa shell: Pale dull brown, the abdomen bright yellowish-red with a brown band on the base of each segment, except on the under side and tip. No hooks at tip; and it lies loose in its pod. 13 mm. long; 3.8 mm. broad.

Distribution (28:8). This species of *Thanaos* has a more northern distribution than any of its congeners, being a member not only of the Alleghanian fauna but also of the Canadian; the northernmost localities from which it has been reported are: Nova Scotia "common" (Jones),

Quebec (Mus. Comp. Zool.), Montreal (Lyman), Nepigon, north of Lake Superior, not included on the map (Scudder), the west coast of Lake Winnipeg (Scudder), Fort Simpson—also received since printing the map (Fletcher), Kananaskis (Fletcher) and Canmore, Alberta (Holland), Vancouver Island (Fletcher) and Washington Territory (Morrison). Yet it occurs also far to the south, occupying at least the northern half of the Carolinian fauna, since it has been taken in West Virginia (Edwards), North Carolina (Atkinson) and Georgia (Abbot). Edwards also gives it from Florida, and I have seen specimens from Mexico (!) collected by Sallé. In the heart of the continent it has been rarely taken except in high northern localities, such as those mentioned; or in elevated situations, as Colorado (Mead, Morrison, Scudder) and Arizona (Morrison); but it has been taken in Michigan (Mus. Mich. Univ.), Wisconsin, not rare (Hoy) and northern Illinois (Worthington); Strecker also gives it from Ohio and Indiana, where it is probably confined to the north. It has not been detected in several places where we should expect it and where there are good observers.

In New England it is wide spread and has been found in almost every place where there are resident collectors. In the north it has been taken in the wilds of Maine (Packard) as well as at Norway (Smith), Hallowell (Miss Wadsworth) and Orono (Fernald); in the White Mountain valleys and even in the subalpine region of the White Mountains in abundance (Sanborn, Scudder) and Milford, N. H. "common" (Whitney); in Massachusetts it is reported from Andover (Scudder), Amherst (Parker), Amherst Notch (Scudder), Springfield (Emery), Middleboro (Hambly) and Nantucket (Scudder), and at several places in the vicinity of Boston, such as Winchester, Belmont, Wyoming and Mattapan. In Connecticut it has been found at New Haven and Meriden (Mus. Yale Coll.) and at New Britain (Scudder).

Abundance and haunts. Open roads through woods in hilly regions, especially if these be damp from the vicinity of streams, will be found the favorite place of resort for this butterfly, which never swarms, but is often found singly in great numbers.

Oviposition. The eggs are laid singly on the upper surface of leaves, the younger but not the youngest leaves being selected for the purpose, and ordinarily at a height of not more than about three to four feet from the ground.

Food plants. Abbot says that this species feeds in the caterpillar state upon "wild indigo" [Baptisia?] and oaks, but as he makes the same statement of others, it is not improbable that several species were confounded by him. Mr. Edwards has raised it on aspen, *Populus tremuloides*, and I have carried it to the fourth larval stage from eggs laid by a female imprisoned on the same plant. Mr. Edwards says he once "had

the same larva here from English filbert [a species of *Corylus* of the allied family Cupuliferae] but the imago failed to appear." This is the larva figured on our plate, but that it certainly belongs to the present species (considering the close resemblance between the caterpillars of some of the species and our lack of familiarity with them ¹) requires verification. Fitch raised a specimen of *Thanaos* from witch-hazel, *Hamamelis*, a widely different plant, and the description of the butterfly he has left in his notes renders it almost certain that it was this species. Finally, when this seemed to be the only species flying at Nepigon, Mr. Fletcher and I found eggs of a *Thanaos* (presumably, therefore, this species) on *Salix cordata*.

Habits of the caterpillar. *Ecclus* makes a nest in the usual manner of the species of *Thanaos*; but the threads are usually very long, so as to leave abundance of space for air or indeed the entrance of nearly any enemy; when the time for a change of skin comes these are all tightened and the edge of the overhanging bit of leaf brought into close contact with the surface opposed to it, leaving only at one end just room enough to crawl out. When the change is effected, and a new home is desired, these threads are completely cut by the caterpillar before deserting the nest, which then remains half opened. During rest the caterpillar remains upside down on the overhanging flap. It eats only the leaf on which its nest is made, but feeds at some distance from the nest and apparently only by night. A caterpillar that had just made its third moult was placed upon a new leaf and worked all night before it was housed again. But before it began work it spent two and one-half hours partly in wandering over the leaf and partly in remaining quiet as if lost in thought as to how it was to do it.

Perhaps this was because it was at midday that he was disturbed, or his organs too tender to work, for at the end of this long time he only ate a round hole at the edge of the leaf twice as big as his head and rested another two hours and a half, this time quietly, then spun a strand across from side to side of the slightly bellied leaf at a little more than his own distance from the edge and again was quiet for another two hours, when he was left for the night. The next morning the cut had been deepened nearly to the midrib, another deep cut had been made to the midrib beyond his strand and four or five more strands made from edge to edge pulling the leaf over, rendering the first strand useless. It had accordingly been cut at one end and dangled, crinkled up, from what was now the roof. The nest, however, was now, eighteen hours after starting, by no means a completed one.

The caterpillar passes the winter in the larval stage within just such a nest as it has lived in all its summer life, thoroughly lined inside with white silk. In West Virginia Mr. Edwards found it full fed in July and before

the end of the month it had stopped feeding; it was then placed in a cool cellar, remained all winter in the same condition and changed to chrysalis in the early spring without eating, and there was no evidence that it ever left its winter home; eight months of the year, therefore, were passed as a full fed caterpillar, showing no signs of active life beyond closing with silk any openings which were made in the wall of its nest, an action entirely similar to that of all the species of *Thanaos* in wintering.

Fitch says that the caterpillar he found September 9, 1858, on witch hazel draws the leaves around it with white threads into a pod and feeds on them, "eating their margins irregularly and occasionally gnawing a hole in them."

Life history. The insect is single brooded and hibernates as a full fed larva; it changes to chrysalis early in the spring, and remaining therein at least three weeks was bred by Abbot in Georgia April 21. Edwards, however, bred it May 13 after only sixteen days in pupa. In New England it appears about the middle of May, the earliest record being May 10, near Boston, and May 11, Nantucket, tolerably common in each instance, only males appearing so early, and they being often delayed until the 20th, when I have taken both sexes. Lintner's earliest printed record at Albany, N. Y., is the 19th, but we have recently found it there on the 17th in some abundance. It becomes abundant in about ten days after its first apparition and is found throughout June, and occasionally, about the latitude of Boston, until the end of the first week of July.

In the White Mountains it never seems to appear before the last week in May, often not until the first of June; may generally be still taken fresh from the chrysalis at the middle of June and usually flies until the end of the first week in July. Miss Wadsworth has taken it at Hallowell, Me., as early as May 20. In Colorado Mr. Mead took fresh males June 10, and not very fresh females June 15, so that the season there is probably much as in the White Mountains; while at Nepigon they were not uncommon and fairly fresh early in July and eggs were laid at that time, hatching just before the middle of the month (so, too, Mr. Fletcher has sent me a fresh female, taken at Fort Simpson June 26); caterpillars from these eggs, when removed to Massachusetts, reached their fourth stage August 8, and would probably have been full fed before the end of August. In West Virginia Edwards found a caterpillar which he took to be in the first stage on June 20 and observed moults on June 27, July 5 and July 16, and thinks one may have escaped him between the last two seen; the caterpillar stopped feeding before the end of July, and after passing the winter in a cool chamber, was restored to normal condition on March 7; yet it was not until the end of April that pupation took place.

Habits of the butterfly. The butterfly rests with outspread wings upon moist sand by roadsides (Lintner). A specimen in the Museum of

Comparative Zoology has both its eyes ornamented with the projecting pollinia of an orchid. One observed by Morrison had symmetrical notches in the costal margin of the fore wings, indicating an injury in the pupal state. The butterfly hugs the ground when on the wing and its flight is not so vigorous as that of its allies, nor does the butterfly struggle so violently when captured; indeed the male is not so strong as the female of the other species. When at rest the wings are flatly expanded, the costal edges of the fore wings at right angles to the body, their inner margin reaching the middle of the costo-subcostal interspace; the antennae, viewed laterally, are, in general, parallel to the body, arched a little throughout their course, and at the tip bent at right angles; viewed from above, they diverge at an angle of 85° , the tip of the club curving downward and a little outward.

Desiderata. Especial search should be made for the early stages of this insect, which are imperfectly known. Its western distribution is unknown, but the widely separated localities at which it has been taken indicate a very extended range. What odor, if any, is given off from the hind tibial pencil of hairs of the male?

LIST OF ILLUSTRATIONS.—*THANAOS ICELUS*.

General.		Imago.	
Pl. 28, fig. 3.	Distribution in North America.	Pl. 9, fig. 6.	Male, both surfaces.
	Caterpillar.	26: 30-32.	Male abdominal appendages.
Pl. 77, fig. 1.	Mature caterpillar.	47: 0.	Scales of the male imago.
	Chrysalis.		
Pl. 85, fig. 27.	Chrysalis.		

PHOLISORA SCUDDER.

Pholisora Scudd.,* Syst. rev. Am. butt., 51 Nisoniades pars Auctorum.
(1872). Type.—*Hesperia catullus* Fabr.

O that it were with me
As with the flower;
Blooming on its own tree
For butterfly and bee
It summer morns.

CHRISTINA ROSSETTI.—*A Summer Wish*.

Imago (56: 3). Head moderately large, clothed with hairs of varying lengths, some quite long and these arranged to some extent in transverse rows; outside the base of the antennae a curving tuft of long, nearly equal, spreading hairs, reaching fully one-third way over the circumference of the eye; front uniformly and but slightly tumid, projecting greatly and especially below, beyond the front of the eyes; front margin gently convex and rather heavily emarginate, the sides well rounded off anteriorly, reaching the outer edge of the antennae; scarcely twice as broad as long and separated from the vertex by a slight sulcation a little in advance of the middle of the antennal bases; vertex as broad as the front, separated from the occiput by an arcuate line, scarcely tumid, but with an obscure, transverse, median, slightly arcuate ridge, curving in an opposite direction to the hinder border, the whole vertex slightly and

* *φολις, ὄψα*, the spotted beauty.

almost equally raised above the level of the eyes; eyes large, full, more broadly curved posteriorly than anteriorly, naked, receding from each other posteriorly as in Thanaos. Antennae inserted with the hinder edge of the base in the middle of the summit, their interior bases separated from each other by more than one and one-half times the diameter of the basal joint, the whole antenna of about the length of the abdomen, composed of thirty-five joints of which sixteen form the club, which is about three-fourths the length of the stalk and curved at a little more than a right angle beyond its middle; it is subtriquetral, though more nearly approaching a cylindrical form than in Thanaos; it increases gradually in size to a little beyond the middle or the most curved portion, where its breadth is equal to fully the length of two joints, and then diminishes considerably more rapidly to a bluntly rounded tip, which on the antepenultimate joint is as broad as the stalk; the joints in the middle of the stalk are fully three times as long as broad. Palpi nearly three times as long as the eye, not very stout, but excepting the apical joint, which stands prominently beyond the others, pretty heavily though somewhat loosely clothed with long scales and hairs, arranged to some extent in a vertical plane; basal joint small, a little longer than broad, scarcely protuberant at any part of the apex; middle joint quite slender, scarcely tumid, cylindrical, with rounded ends, more blunt at apex than at base, a little curved, the convexity forward, nearly three times as long as broad and fully two and one-half times longer than the basal joint; the apical joint small, slender, straight, cylindrical, nearly three times longer than broad, bluntly pointed at tip and half as long again as the breadth of the middle joint, directed angularly forward.

Prothoracic lobes small, strongly compressed, almost laminate; viewed from the front subtriangular, rounded, the base above; upper edge strongly arched, the angles rounded, the piece nearly as high as broad, the breadth about two-thirds the diameter of the eye. Patagia large, resembling those of Thanaos, the posterior lobe equal, broadly rounded at the tip, the length of the whole piece equal to the distance from the base of one eye to the extreme centre of the other.

Fore wings (41:8) triangular, less than twice as long as broad, the inner margin a fourth longer than the outer; costal margin scarcely arcuate, outer margin regularly and gently arcuate; inner margin straight; apex of the wing roundly angulated. Costal margin thickened only on the basal fourth; costal vein terminating shortly before the apex of the cell; inferior subcostal nervule and the two outer superior costal nervules originating at equal distances apart and twice as near as the distance from the origin of the third to that of the second; this last is slightly nearer the third than the first, and the first originates at three-fifths the distance from the base to the apex of the cell, opposite a point midway between the origin of the first and second median nervures; basal bent portion of the inferior subcostal nervule longer than usual and obsolete, as is also to a slight degree the subcostal nervure just before where it is bent down to receive it; vein closing the cell likewise obsolete, indicated only by the bend of the nervures; first median nervule originating scarcely beyond the end of the basal third of the cell; the second a little beyond the base of the second subcostal nervule; internal nervure very brief, fine, distant from the submedian and terminating abruptly; cell expanding regularly and gradually almost to the tip and about four times as long as broad, and nearly two-thirds as long as the wing.

Hind wings rounded triangular, elongate in the subcostal region, considerably longer than broad; costal and inner margin straight, or the former slightly arcuate; the outer margin strongly arcuate, more strongly above than below, with not the slightest production in the submedian region, entire. Costal and subcostal nervures running at first parallel, enclosing the usual lacuna, which is very slight, the veins parting at a short distance from the base and at no great angle either from each other or from their former course; the subcostal forking at about two-fifths the distance to the margin; the cross vein indicated only by the slightest possible bending of the subcostal and median nervures; the second median forking is scarcely further from the base of the wing than the subcostal forking; internal vein nearly as long as the submedian and with a similar arcuation.

Scales enclosed in the costal fold of the fore wings of the male very variable in form and including as special types flexible chain-ribbons and long straight rods, besides androconia mainly of two lengths; no forked rods appear nor flagellate androconia.

Legs 2, 3, 1. All the femora thinly fringed beneath with not very long hairs, on the fore femora with short hairs; the middle and hind tibiae fringed above still more thinly with pretty long hairs. Femora, 2, 1, 3; tibiae, 2, 3, 1; tarsi, 2, 3, 1. Fore and hind femora of equal length and two-thirds the length of the mid-femora; fore tibiae hardly more than half as long as the fore femora, more than two-thirds as long as the hind tibiae, and about two-thirds as long as the middle pair. Leaf-like appendages of fore-tibiae originating just beyond the middle of the joint, slender, a little more than four times as long as broad, the apical half tapering and curved, extending some distance beyond the tip of the tibia; other tibiae furnished at tip beneath with a pair of long, moderately stout spurs, the hind tibiae also with a precisely similar secondary pair at about the middle of the outer two-thirds. Tarsal joints, 1, 2, 3, 4, 5; fore tarsi about two-thirds as long as those of the other legs, scarcely longer than the middle tibiae—all with a triple row of delicate spines beneath, the apical ones of each joint scarcely longer than the others; basal joint as long as the second, third and fourth together on the hind legs, scarcely longer than that on the others; second joint half as long as the first on the middle and hind legs, two-thirds as long on the fore-legs. Claws small, slender, tapering, bent before the middle at a rounded right angle, beyond which it is scarcely arcuate; pad small, transverse; paronychial very slender, nearly straight, equal, nearly as long as the apical portion of the claw.

Upper organ of male abdominal appendages with the centrum small, the summit depressed, ovate, anteriorly marginate, slightly overlapping the hooks; hooks consolidated for a greater part of their course, forming a depressed lamina of nearly equal width, tricuspid at the tip; lateral arms extending far downward as in *Thanaos*, uniting to form a horizontal triangular plate. Clasp long and rather narrow, more than three times as long as broad, considerably convex, nearly equal, the superior lobe inconspicuous and nearly apical, both upper and lower apical angles produced to more or less pointed and prickly lobes.

Egg. Short, sugar-loaf shaped, broader than high, tapering from the very base; the lower three-fifths furnished with a considerable number of but slightly elevated and rather narrow vertical ribs, and the space between them broken by frequent, straight, wedge-shaped cross lines, very nearly as high as the vertical ribs; upper two-fifths of the egg entirely different, every two or three of the vertical ribs uniting abruptly to form an excessively coarse and irregular, rounded, vertical ridge, running to the micropyle rosette, and connected by infrequent, irregular cross lines, not so high as below. Micropyle rosette in a deep pit, circular, made up of a minute, circular, central cell, surrounded by kite-shaped cells, and these by larger polygonal ones.

Caterpillar at birth. Body furnished with several rows of long, equal, straight, apically expanding bristles, arranged as follows: a laterodorsal row, one to a segment, placed on the extreme anterior edge of the segment; a supralateral row anteriorly placed, one on each segment, becoming lateral on the thoracic segments; infralateral posterior and suprastigmatal central rows, with one to each segment, and an infrastigmatal central row, one to each segment. On the first thoracic segment the dorsal shield is moderately conspicuous and the bristles are slightly longer than elsewhere, and curve a little forward; those of the head are of the same length as on the body, but are bluntly pointed at tip. Hooklets of the prolegs, about twenty in number, forming a broad, oboval series.

Mature caterpillar. With the general aspect of *Thanaos*, but much more slender. Head broader than high, rounded, with a broad and blunt median notch, each hemisphere well rounded; as seen from the side, regularly narrowing from below upward, pretty heavily rugose, covered with a moderately dense pile of branching hairs. Frontal triangle nearly half as high again as broad, narrowing almost entirely in the upper half with an arcuate margin.

Body moderately stout, largest in the middle, and nearly equal over more than half

the body, tapering toward either end, but more regularly and gently behind; transversely arched with a somewhat flattened ventral surface, the last abdominal segment not greatly broader than long, regularly rounded behind, the first thoracic segment with the usual dorsal shield, transversely sulcate almost to the spiracles; the posterior transverse intersegmental folds of the abdominal joints three in number and occupying together about two-thirds the space of the broad anterior section, which is partially divided by a transverse crease in the middle of its posterior two-thirds, and has, mesially, on the abdominal segments, a series of minute, suprastigmatal lenticles, no larger than the low papillae, and a series of slightly larger, minute, circular, laterodorsal lenticles. Legs and prolegs very short.

Chrysalis. Moderately slender, well rounded; viewed from the side the upper surface has two gentle curves, on either side of the dividing line between the thorax and the abdomen, of about equal height, or the thoracic the higher and in any case stronger, and rather stronger behind than in front; the head tapers both below and above, so that there is no apparent bending downward of the head; viewed from above the body is nearly equal from the basal wing tubercle to the tips of the wings, but with an exceedingly gentle fullness, so as to be broadest at about the second abdominal segment; posterior to this the abdomen tapers with moderate rapidity to what, but for the cremaster, would be a bluntly rounded extremity; the basal wing tubercle scarcely in the least prominent and rounded, with a scarcely perceptible carina following it posteriorly to the middle of the wing cases, but so rounded as to be extremely obscure; front broadly rounded, but the basal antennal joints and front proper with independent arcuation, that of the front the stronger; the tongue sheaths show a distinct, though slight, rounded prominence, as far from their extreme base as this from the front of the head; a transverse series of suppressed tubercles crosses the appendages of the front, midway between the base of the tongue cases and the tip of the antennae; the latter fall as far short of the extremity of the wings as they are beyond this transverse tuberculation, while the tongue barely surpasses the extremity of the wing cases; hairs of the body long, slender, smooth, straight, regularly tapering to a fine point. The preanal button consists of a pair of broad, reniform, independently swollen plates in a common field, separated from each other by a straight, fine sulcation and from the surrounding region by a deeper, sharply marked sulcation. Cremaster strongly contracted at the very base, the portion beyond as viewed from above nearly quadrate, with broadly rounded apex and rounded external angles, very deeply and triangularly sulcate basally, not extending over half its length; beneath with a broad, rounded excavation; the whole depressed, tapering slightly as viewed from the side. Hooklets wholly apical, not numerous but crowded, strongly arcuate, enlarging from near the base to tip, forming short, strongly compressed hooks, often tightly colled, the extreme tip bluntly pointed.

This American genus contains but few species, which are found in southern North America and northern Central America exclusive of the Antilles. The most widely extended species is that described below, which is spread over most of the United States including the southern portion of New England.

The butterflies are of small size, with ample wings, shaped as in the preceding genus. They are very dark, almost black, and uniform in appearance, having scarcely any other markings than a few small, white spots in an arcuate row upon the outer half of the fore wings.

The history of our northern species is best known; this is multibrooded and hibernates as a mature caterpillar, changing to chrysalis, without feeding, in the early spring. The caterpillar feeds on plants of the *Amaranth* family and its immediate allies, and the butterfly frequents the open country.

The eggs are very peculiar in being heavily lobed above vertically in a radiate manner, each lobe rounded and arched and corresponding to a vastly thickened continuation of every alternate vertical rib, which otherwise is normal. Edwards aptly compares them to a confectioner's cake-moulds, and adds that their red-brown color makes them look like a speck of dust on the leaf.

The caterpillars resemble those of *Thanaos*, but are slenderer than they and of a brighter color.

The chrysalids closely resemble those of *Thanaos*, but differ from them exactly as do the caterpillars.

EXCURSUS LVIII.—THE PERILS OF THE EGG.

He who bends to himself a joy
Does the winged life destroy;
But he who kisses the joy as it flies
Lives in eternity's sunrise.

BLAKE.—*Opportunity.*

ANYBODY who has attempted to procure the laying of eggs out-of-doors by butterflies and left them there to hatch, must have observed the mortality among them, due to the simple voracity of entomophagous insects. The chief offenders are mites and spiders of different kinds, and ants who seem as fond of animal as of the sweeter vegetable juices. I one day left a *Vanessa cardui* entrapped on a thistle and in a brief time she laid several eggs; but when I went a second day to see if there were others, I found only the bases of eggs which had been laid by her, with a single exception; this egg presented a peculiar appearance, for a pair of ants were tugging at it, and had just succeeded in piercing it above so that the egg was spoiled for me. I have found it therefore advisable in all cases to remove eggs to the house as soon as obtained from the female, if one does not wish to suffer a large percentage of loss. Others have had the same experience. Mr. Edwards writes:—

“There is a monstrous waste of eggs in interrogationis; out of the thousands which must have been laid by, say, thirty females hardly twenty butterflies resulted. I have watched the eggs and they are carried off and no trace left. I suppose by spiders. I had a lot of *ajax* eggs laid in a keg over papaw and had left them there to hatch, though I usually cut off the stem and hatch the eggs in the house. I took off the cloth one evening to let the eggs get the night air, and in the morning there was no trace of an egg on the plant. So it happened with *atalanta*.”

Nor are these minute objects by any means free from the attacks of parasites, which pass their entire existence within this narrow compass. Witness the not inconsiderable list of the excessively minute Hymenoptera of the genera *Trichogramma* and *Telenomus*, all of which have been raised

by the merest accident from eggs collected in the field. The five known kinds have already been found on the eggs of twelve different species of American butterflies. Were this mode of collection more commonly and authentically employed, doubtless the list would be vastly extended. It is a curious fact that there are no cases known to us of parasitic attack upon those eggs which winter and are, therefore, subjected for the longest period to such chances.

I am inclined to believe that on the whole the greatest destruction of lepidopterous life occurs during the egg-period; certainly if the very first larval stage be added to it, while the caterpillar wears the same clothing it had in the egg, the statement would be unquestionably true; the escape of the fortunate must be laid to three considerations: the minuteness of the objects, their extreme numbers and ordinarily the brevity of the period; enemies which attack a given species only in the egg state must be on the alert when the egg period lasts only a fiftieth part of their victim's life. That they are on the alert is shown by the very facts of wholesale destruction, and no fact is more significant than that related above by Mr. Woodworth, on p. 98, of his capturing *Telenomus graptæ* at work laying its eggs in those of *Euvanesa antiopa* as fast as she deposited them. Here was the struggle for the perpetuation of species indeed!

PHOLISORA CATULLUS.—The sooty wing.

[The black skipper butterfly (Abbot and Smith); the sooty skipper (Gosse); white dotted black skipper (Maynard).]

Hesperia catullus Fabr., entom. syst., iii: 343 (1793);—God., Encycl. méth., ix: 725, 777 (1819);—Westw., Don. Ins. Ind., 70, pl. 50, fig. 4 (1842).

Papilio catullus Smith-Abb., Lep. ins. Geo., 47-48, pl. 24 (1797);—Abb., Draw. ins. Geo. Br. Mus., vi: 77, figs. 108-109; xvi: 52, tab. 34 (ca. 1800).

Nisoniades catullus Westw.-Hew., Gen. diurn. Lep., ii: 519 (1852);—Morr., Syn. Lep. N. Amer., 115 (1862);—Butl., Catal. Fabr. Lep., 286 (1869).

Thanaos catullus Butl., Entom. monthl. mag., vii: 97 (1870).

Pholisora catullus Scudd., Syst. rev. Am. butt., 51 (1872); Butt., 309, fig. 14 (1881);—French, Rep. Ill. Ins., vii: 162 (1878); Butt. east. U. S., 367, fig. 87 (1886);—Edw., Can. ent., xvii: 245-248 (1885);—Mayn., Butt. N. E., 56, pl. 7, figs. 83, 83a (1886).

Ancylozipha catullus Hew., Cat. coll. diurn. Lep., 246 (1879).

? *Hesperia lherminier* God., Encycl. méth., ix: 725, 777-778 (1819).

Figured by Glover, Ill. N. A. Lep., pl. 30, fig. 7; pl. 37, fig. 6; pl. B, fig. 13, ined.

Life is not sweet. One day it will be sweet
To shut our eyes and die:
Nor feel the wild-flowers blow, nor birds dart by
With flitting butterfly,
Nor grass grow long above our heads and feet.

CHRISTINA ROSSETTI.—*Life and Death.*

Imago (♂: 2). Head covered above with black or purplish black scales and hairs marked distinctly with white or yellowish white; the transverse ridge between the antennae is meagrely edged in front with white, and the entire circuit of the eyes except at the base of the palpi is edged with alternate and nearly equal spots of black

and white, one of the white ones lying just behind the antennae and another just in front of the same; connecting the anterior edges of the latter is a transverse line of infrequent hairs similar to the one connecting the front of the antennae, and down the middle of the upper part of the head are other small white spots in transverse lines with those bordering the eyes; the long tuft of curving bristles outside the antennae blackish brown. Head beneath white or yellowish white, excepting where, next the eyes, it is interrupted with black. Palpi, excepting the last joint, white beneath, with a few dusky or blackish bristles externally; above rich dark purplish brown; the middle joint tipped above with some white elongate scales; apical joint wholly blackish. Antennae very dark purplish brown, the apices of the joints flecked faintly with white or pale yellowish, especially beneath on the inner side; crook naked and colored similarly to the club but lustreless. Tongue black, dark castaneous at tip.

Thorax covered above with blackish, chocolate brown hairs, the prothorax edged anteriorly with a few white hairs. Beneath, with uniform, very dark purplish brown scales and hairs, excepting in front where the anterior face of the prothorax and the coxae of the fore legs are covered with white. Legs uniform, very dark purplish brown, the spurs similar; leaf-like appendage of fore tibiae luteo-fuscous; spines yellowish brown; claws the same, but a little darker; pad dusky.

Wings above blackish brown, generally with a chocolate, sometimes with a purplish tinge. *Fore wings* with a small white spot near the extremity of the cell below a point midway between the origin of the second and third superior subcostal nervules; occasionally, especially in the ♀, there is a second, scarcely smaller, spot in the cell just beneath this; in the middle of the outer half of the wing a very sinuous series of white dots or roundish spots occasionally obsolete in the lower half of the wing, and when present almost invariably larger in the upper than in the lower half, and often quadrate especially next the costal margin; the upper two spots, situated on either side of the nervule which runs to the apex of the wing, are at right angles to the costal margin in the middle of the outer two-fifths of the wing; the next three, in the three succeeding interspaces, as far as the upper median nervule, curve regularly and strongly outward, the lowermost opposite the middle of the distal half or three-fifths of the upper median nervule; the lower four form a zigzag line in the median and submedian interspaces; the second occupies the middle of the lower median interspace; the first is on a line with that and the spot in the subcosto-median interspace, but a little nearer the former; the lowest two are both in the same interspace, parallel to the spots in the median interspaces, in a line at right angles to the middle median nervule and which passes through the lower median spot, passing between the spots of the medio-submedian interspaces; distant from the outer border by about the width of an interspace is a submarginal series, slightly more curved than the border, of nine longitudinally oval, uniform, faint, pale spots made up of flecks of very pale blue scales, sometimes scarcely discernible. Fringe concolorous with the wing. *Hind wing* uniform, except in having, at a distance from the outer border of about one and one-half interspaces, a row of spots similar to the submarginal ones of the fore wings, but more frequently obsolete. Fringe like the wing.

Beneath very dark uniform brown, generally, and especially on the hind wings, tinged with purplish; the distinct markings of the upper surface of the fore wings are repeated beneath with even greater distinctness, but the spots of the lower half of the wing are more frequently obsolete and the series is sometimes reduced to the upper three spots; otherwise both the wings are without markings and the fringe is concolorous with the wing.

Abdomen uniform blackish brown; lamina formed by the hooks of the upper organ of the male appendages (35: 41-43) slightly arcuate, the teeth equal, distant and slightly divergent, each about half as long as the width of the lamina, not tapering, blunt at the apex, the lateral ones curved downward; the whole lamina shorter than the centrum; sheath formed of the lateral arms large, extending nearly as far back as the teeth of the lamina. Clasps three and a half times longer than broad, the upper and lower edges incurved, the former bearing before the middle a small triangular pro-

jection; upper lobe very nearly apical, small, rounded, directed backward; docked or roundly excised extremity of the blade so convex as to appear semicircular on an end view, the upper angle a little produced and prickly, the lower bearing a recurved, interior, triangular process terminating in a sharp thorn and having the edges minutely denticulate.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	12.2	13.25	14.	13.	13.5	15.1
antennae.....	6.	6.25	6.5	6.1	6.4	6.55
hind tibiae.....	5.25	6.	6.25	5.35	5.6	6.25
fore tibiae and tarsi.....	3.5	3.8	3.9	3.4	3.5	3.75

Described from 17 ♂, 18 ♀.

Accessory sexual peculiarities. The costal fold of the fore wing of the male encloses some very long attenuated rods of an exceptional length, being sometimes .75 mm. long (48: 1 a); plenty of twisted flexible chain-bristles with links varying in number but apparently not exceeding twelve (1 k), which seem to vary in length and width according to the point of view but not to exceed .02 mm. in length, and which are not flagellate at tip but well rounded; besides these a great assortment of forms of small scales but mostly boat-shaped (1 b, e-l), drawn on the plate to the same scale as the last, and apparently of a granular structure; and finally irregular, rounded and striate cover scales (1 c d) close the opening of the fold.

Egg (66: 21). Vertical ribs about eighteen in number, horizontal lines about twelve to fourteen between each set of vertical ribs, leaving no part of the field flat; ridges seven in number, minutely tuberculate and radiate from the centre in a stellate manner. Micropyle rosette (69: 2) formed of a central, minute, circular cell, from which nine kite-shaped cells, twice as long as broad, radiate, these by a row of nearly circular cells, their diameter equal to the length of the kite-shaped cells and these by a still larger hexagonal series, whose diameter averages about .0125 mm. Color according to Riley yellow, inclining to caraceous; specimens sent me by Miss Murtfeldt were white, the extreme base reddish brown, probably at a later period. Height of egg, .44 mm.; width, .58 mm.; micropyle pit, .11 mm. in diameter.

Caterpillar. First stage. Head (80: 43) black, almost smooth, but delicately, very shallowly and irregularly vermiculate; bristles dusky; mouth parts black. Body yellow, black at tip; the bristles of the body pellucid; legs dusky; prolegs of the color of the body. Breadth of head, .3 mm.; length of bristles, .03 mm.

Second stage. Head black, made slightly gray by the white hairs. Body pale yellowish green, greenest in the middle of the body, dotted rather sparsely with pale papillae, each with a short, pallid hair. Dorsal shield of first thoracic segment of the color of the head, unbroken in the middle above, but with a separate piece for the spiracle. Legs and prolegs concolorous, first pair of legs infuscated. Length, 6.5 mm.; width of head, 5 mm.

Third stage. Head as before. Body pale yellowish green, the last thoracic and first four abdominal segments pale green, all with a moderate scattering of pale yellowish, small but unequal papillae, giving rise to short, pale hairs. A faint, slender, green, dorsal line, and faint, slender, yellowish lateral and stigmatal lines, largely from the clustering of the papillae; dorsal shield of first thoracic segment as before, but with a distinct but very slender medio-dorsal break. Spiracles pale yellow. Legs and prolegs as before. Length, 8.5 mm.; breadth of head, 1.25 mm.

Fourth stage (77: 21). Head and dorsal shield of first thoracic segment as before. Body pale bluish green, the last two or three segments and all the skin-folds tinged with yellowish, the papillae pale, with hardly a tinge of yellow; dorsal stripe as before, but the lateral and stigmatal lines very faint and inconspicuous; spiracles luteous. Legs and prolegs concolorous. Length, 12 mm.; breadth of head, 2.25 mm.

Last stage (77: 16, 23). Head (80: 44) blackish brown, deeply infuscated along the middle line, especially above, behind deepening into black, covered with a thin pile of

fulvous hairs mixed with black; labrum fusco-testaceous with a luteous base; ocelli, mandibles and last joint of antennae black, the ocelli tinged with testaceous.

Body dull pale green, a little tinged with yellowish on the last abdominal segments, and also faintly at the folds, completely and pretty uniformly flecked with pale dots, which, however, form an indistinct, pale lateral line by their disposition at that point, each of the dots being a wartlet from which arises a short, pale hair. The dorsal shield of first thoracic segment is pallid around the margins, velvety black across the middle, with a mediodorsal break; in its hibernating condition it becomes concolorous and the body has a roseate tinge; the prolegs are concolorous with the body, as are the slightly infuscated legs, the claws of which are dusky. Laterodorsal warts fuscous, pale centrally; spiracles fusco-luteous. Length of body, 21 mm.; breadth of head, 3 mm.; of first thoracic segment, 2 mm.; of middle abdominal segments, 3.25 mm.

Chrysalis (85:29, 36, 41). Chrysalis yellowish green, with brownish dorsal line, and a similar ventral line on the abdomen, according to Riley. A chrysalis case before me, from which the imago has escaped, is of a testaceous color, more or less obscured with brownish fuscous, especially in the transverse striations upon the posterior part of the thorax and the whole of the abdomen; the wing cases are much obscured with blackish fuliginous, as is the anterior extremity of the body; and the entire surface is rendered completely hoary by a cottony, bluish white bloom; prothoracic spiracle margined with black; the hairs, which are pretty uniformly distributed over the whole body, are about as long as the abdominal segments and have a pale foxy color. Length, 12 mm.; breadth, 3.75 mm.; length of hairs, .4 mm.

Other descriptions of the early stages. Miss Murtfeldt sent me in 1871 the following good descriptions of all the stages:—

The *eggs* are about .04 inch in diameter, of a pinkish color, nearly round, indented at top and beautifully ridged and punctured. They were deposited singly on the upper surface of the leaves, seldom more than one upon a leaf. They hatched about August 20th.

The *larvae* when first disclosed measured .06 inch in length, and the diameter is uniform throughout; it is of a deep orange color. The head is polished, black, and much larger proportionately than at a later period in its growth. After the first molt the larvae become green in color, and the surface acquires a granulated appearance; the head also loses its polish, so that the young from this time differ from the mature larvae in nothing except size and in being less spindle-shaped.

The *mature larvae* measured from .8 to .9 inch in length, broadly fusiform, the greatest diameter being .2 inch at the [fourth and fifth abdominal] segments. Head free, oblique, about .11 inch in diameter, somewhat rounded in front and cordate above, of a deep dull black color, roughened with minute punctures and with a short, whitish pubescence; mandibles broad, polished, black. Neck narrow, black, very much constricted. First [thoracic] segment but little larger than the neck, cervical collar smooth, somewhat polished, marked with a narrow, transverse black stripe interrupted on the apex and bounded on either side by a somewhat broader stripe of greenish or cream white. The color of the remaining segments is a uniform pale, dull, olive green, and the entire surface is thickly covered with minute yellowish granulations, and under the lens with a fine, short, clubbed pubescence; a narrow, dark, vesicular dorsal line can also be distinguished. Stigmata minute, pale green. Ventral surface flattened, rather paler than dorsum, and not so thickly granulated. First pair of thoracic legs black, or tipped with black; second and third pair polished green; prolegs concolorous with upper surface.

The *chrysalis* is oblong, smooth, .5 inch in length, purple, covered with a fine white powder, like the "bloom" on a dark plum or grape. It is found inside of the leaf case inhabited by the larva, and is loosely enclosed in a frail, dingy white cocoon, woven in very open meshes, like lace. It is suspended by the tail, and has no bands to support it in a particular position.

Geographical distribution (29:1). This butterfly is widely spread throughout nearly the whole extent of the Carolinian and Alleghanian faunas, but it has not been reported from Florida; Abbot, however, says it is found in Georgia though not very common. Gosse found it in Alabama and it is common enough from central Texas (Belfrage) to the Mexican border (Lintner, Aaron), and there is even a specimen in the British Museum said to come from Brazil! I find it nowhere given as an inhabitant of Mexico, but Palmer brought specimens from San Luis and Saltillo. In our own territory it extends from Atlantic to Pacific, occurring on the Pacific coast from Sonora (Lorquin), through California (de l'Orza), Oregon (H. Edwards), to as far north as Eskimault, Vancouver Island (Fletcher). Information concerning the last was given me after the map was made. In the Rocky Mountain region it was noted long ago by Reakirt in Colorado, where it has since been obtained at Denver (Mead, Uhler), Clear Creek Cañon (Uhler), Engelmann and Platt Cañons (Snow), as also in New Mexico (Snow), Arizona (Doll, Morrison), in Utah at St. George, and Pine Mountains (Palmer) and at Great Salt Lake, Beaver Brook and American Fork Cañon (Scudder), as well as in southern Utah, by Mead, and finally in Nevada by H. Edwards. Between the Rockies and the Alleghanies the northernmost points at which it has been noted are Wallace County, Kansas (Snow), Iowa, at Grinnell (Parker), and Ames (Osborn); Wisconsin, common (Hoy); northern Illinois (Worthington); Michigan (Museum of the University of Michigan); and northern Ohio (Kirtland, Kirkpatrick, and British Museum). On the Atlantic coast outside of New England, the northern points at which it has been taken are northern New Jersey (Andrews, Merrill), Staten Island (Davis), Long Island (Graef) and of late years in New York at Bethlehem and Albany (Lintner). It has also been many times reported as a Canadian species by several collectors, but until recently all specimens I had seen so labeled had been wrongly determined; latterly it has been credited to the vicinity of Quebec (Bowles) and the hills in the Province of Quebec, bordering on Vermont (Fyles), and Fort Ellis, Manitoba (Geddes).

In New England it is not an uncommon insect in some southern localities, notably along the Connecticut River—as the vicinity of New Haven (Smith, Yale Coll. Mus.), Guilford and Meriden (Smith—Mus. Yale Coll.), Plantsville (Shepard, Mus. Yale Coll.) and Farmington, Conn., “not common” (Norton) and Springfield (Emery, Dimmock, Sprague), Northampton (Hamby), Mt. Tom and South Hadley (Sprague) and Amherst, Mass. (Parker); the only other localities where it has been found in Massachusetts are Boston (Scudder) and Middleboro (Hamby); its northernmost recorded localities are Milford, N. H., “very rare” (Whitney) and Norway, Me. (Smith).

Haunts and abundance. Abbot says it is to be found about gardens and fields and among melon blossoms; he also adds that it frequents corn fields, near oak woods, but he seems to have found nearly everything in or near oak woods. Edwards says he has often observed it about melon and cucumber patches, alighting on the leaves, and it is about manured grounds, not very carefully cared for, that *Chenopodium* best flourishes. Dr. Merrill usually found them in fields of white clover.

Edwards says it "is somewhat abundant in some years" in West Virginia; and Mr. Lintner that it only appeared a few years ago about Albany, a single specimen being taken in 1876; but that three years later it was one of the commonest butterflies. It is invariably abundant in Missouri.

Oviposition. Edwards says that "the egg is laid singly on the upper side of a leaf, sometimes near the edge, but generally near to the midrib"; those I have seen were laid near the middle of the upper surface of leaves, but not on the midrib, and Mr. Riley writes that they are always on the upper surface. Mr. Edwards adds that he has "often found several eggs on a stunted plant not more than two or three inches high growing on the gravel walk." The duration of the egg state, according to Edwards, is about five days.

Food plants. The proper food of this caterpillar appears to be species of the allied families, *Chenopodiaceae* and *Amarantaceae*. Miss Murtfeldt finds it easily at any time on *Chenopodium album*, which is doubtless what is meant by Abbot when he gives "lamb's quarters" as one of its food plants; I suspect it is this plant also which Edwards considers its food when he specifies "pigweed," that being one of the common names of *Chenopodium album*, although Edwards himself adds the generic name of quite a different plant—*Ambrosia*, one of the *Compositae*. I have also reared it on *Chenopodium*. Miss Murtfeldt tells me that it also feeds upon *Amarantus albus*, and Mr. S. Lowell Elliot writes that it will feed on any of the wild species of the *Amaranth* family. Perhaps it is to one of these two families that are to be referred the unknown plants, "common and red careless," to which Abbot also refers as food plants. Abbot also gives two other plants of the *Labiatae*, the horse mint, *Monarda punctata*, upon which he figures it, and wild marjoram, *Origanum vulgare*. I could not persuade it to eat *Monarda fistulosa*, belonging to a different section of the genus.

Habits of the caterpillar. Miss Murtfeldt writes that "when very young the larvae have not the necessity for, nor the power of forming a case the full size of the leaf. The first covering, therefore, that they provide for themselves is made by partly cutting out, folding over and fastening down a small portion of the edge of the leaf and when this habitation becomes too small, they forsake it and form another in the same manner,

and usually it is not until they are one-third grown that they make their permanent larval habitation." They are then "concealed in separate cases formed from the leaves which are folded along the midrib, the edges being fastened together by a few strong stitches of white silk, at intervals of from one-fourth to one-half an inch. These cases form the permanent home of the larvae, the latter remaining curled up and hidden in them during the day and emerging from them only at night to feed." Edwards's account is as follows:—

The young larva goes to edge of its leaf, cuts in about one-tenth inch, and folds over a corner so separated, binding it down by two or three threads. Here it lies concealed till the first moult has passed, and feeds on the fleshy part of the leaf within the fold. After first moult, the larva draws the leaf together by the edges, and from second moult on the hiding place is readily distinguished by the oval swelling of the leaf. When about to moult the case is thickly lined with silk, and closed at every point. The larvae come outside to feed and return to their cases, and feeding takes place at night. Some of my examples were kept in tin boxes, and on one occasion I surprised one of the larvae feeding at a distance from its case; at another, one was close to the opening and hastily retreated into the case, tail foremost, as I opened the box. They are perfectly neat in their cases, the frass being always expelled or voided outside. At any time after the first stage and to maturity, on slitting a case, the larva will be found lying with anterior segments bent round so that the head comes a little beyond middle of body, and in nearly every instance I have found the tail toward the closed end of the case. (Can. ent., xvii: 246-247.)

Riley notes that when well grown the caterpillars "draw either one larger leaf or two smaller ones with the edges together and fasten them with a few threads so that they make a hollow tube in which they feed in a curved position." The nests I have seen were also made, sometimes of one leaf, sometimes of several, but by tightly sewing the edges together, leaving only the hole for exit. The nests so constructed are not tubular but oval chambers with much more room than is actually required by a caterpillar of the size occupying it.

The hibernating nests of the caterpillar. "Near the end of September," writes Miss Murtfeldt, in continuation of her account, the caterpillars then in cases "ceased to feed and remained within their leafy dwellings, or sought other secluded nooks in the breeding cage, engaged in preparations for the coming winter. If inside of the leaves, the latter were lined with a tough, silken substance or fabric, of a brownish color, or, if outside, they enclosed themselves in irregular cocoons of the same prime material, which was evidently waterproof and calculated to secure the manufacturer as far as was necessary from the cold, and were very different from the delicate cocoons of the summer broods. Before October 1st the larvae had all established themselves in winter quarters and were resigned to their long torpid rest."

"I found by carefully opening the cocoons from time to time (which the larvae inside always closed again) that these insects remained in the

larva state until about the middle of April. At this date they changed, and the butterflies issued from the 1st to the 15th of May."

Edwards writes as follows regarding the hibernating nests of the caterpillar:—

I have, as I write, 13th September, 1885, two larvae in hibernation, one of them under a leaf on a bit of paper. The leaf is moulded to an oval, rather a half oval, cut lengthwise, the edges flattened all round, and everywhere bound to the paper by close web, so that quite an effort is required on my part to raise the edge in the least. The other caterpillar lies under a small, oblong slip of paper upon a larger piece which at one end is bent considerably. At that end the opening between the two is a half circle. This is closed by a sort of lace work, full of small openings, and the web spun first is strengthened by several stout threads which lie upon it and cross in various ways. This sort of drum-head covering would resist a strong attack of any enemy but a bird or mouse. The other three sides of the slip of paper are held down by stout threads or cords each of very many fibres, having their attachments upon bases of web thickly spread upon the under paper and at the edges of the upper one. How these threads are brought together at the middle into such a cord is not apparent, but they seem to be laid side by side and cemented. In color these cords are black, while the web itself is pale brown. One cord holds the end of the slip, two hold one side, one of them near either end, and three hold the other side. In addition to this the three sides have web woven all round within. This is the sort of foresight these larvae exercise in providing for hibernation. (Can. ent., xvii: 247-248.)

Life history. In the north it is probably double, in the south triple, brooded, and is presumed to hibernate everywhere as a caterpillar. In the south the spring brood appears early in spring. Palmer took specimens in Arizona in April and May and Abbot reared one specimen in the middle of March; the second comes in June after eight days in the chrysalis (Abbot), continues to emerge through the month and eggs are laid entirely through July. Most of Miss Murtfeldt's caterpillars of the first brood changed to chrysalis in Missouri about the middle of June. The third brood flies through August after seven days in the chrysalis (Abbot, Edwards). The eggs are laid abundantly in the latter part of August and the caterpillars, according to Miss Murtfeldt, "mature much more slowly and were feeding for nearly a month." They begin to prepare for the winter at the end of September. The last two broods, however, according to Miss Murtfeldt, "are not rigidly defined, and consequently the insects may be found in all stages of development from the first of June to the middle of August." In New England, the earliest brood of butterflies appears toward the middle of May (May 12, Smith) and fresh specimens continue to emerge until early in June; this brood continues on the wing until at least the middle of June; the second brood appears very late in July and probably flies until September, fresh specimens being found until near the middle of August. Caterpillars sent me in various stages of growth in the latter part of August by Mr. Elliot, from New York, acted as if intending to hibernate, but a single one changed to chrysalis and emerged about the middle of September—an attempt at the third brood of the south.

Parasites. Miss Murtfeldt and Messrs. Riley and Elliot have all obtained the same parasite from the caterpillar, *Apanteles pholisora*. Miss Murtfeldt has also reared *Microdus sanctus* (88: 10) and Mr. Riley *Limneria fugitiva*, so that the creature seems to have its fair share of enemies, more indeed, than are known for any other of our *Hesperidae*.

Desiderata. This is one of our best known *Hesperidae*, but its annual history needs verification and amplification at every point; the incoming and outgoing of each brood, the points where digoneutism becomes trigoneutism, the habits, flight and postures of the butterfly, the range of food plant of the caterpillar, and the northern line of distribution have still to be carefully worked out.

LIST OF ILLUSTRATIONS.—*PHOLISORA CATULLUS*.

General.		Chrysalis.	
Pl. 29, fig. 1.	Distribution in North America.	Pl. 85, fig. 29, 36, 41.	Chrysalids.
88: 10.	<i>Microdus sanctus</i> , a parasite.		Imago.
	Egg.	Pl. 9, fig. 2.	Male, both surfaces.
Pl. 66, fig. 21.	Egg.	35: 41-43.	Male abdominal appendages.
69: 2.	Micropyle.	41: 8.	Neuration.
	Caterpillar.	48: 1.	Scales of the male imago.
Pl. 77, figs. 16, 23.	Mature caterpillars.	58: 3.	Side view, with head and appendages enlarged, and details of the structure of the legs.
21.	Caterpillar, fourth stage.		
80: 43-44.	Front views of head, stages I, V.		

HESPERIA FABRICIUS.

<i>Hesperia</i> Fabr., Ent. syst., iii, i: 258 (1793);— Scudl., Proc. Amer. acad. arts sc., x: 187-189 (1875).	<i>Syrictus</i> Boisil., Icones Lep., 230 (1832-33). <i>Scelothrix</i> Ramb., Cat. Lép. Andal., 1: 63 (1858).
<i>Pyrgus</i> Hübn., Verz. bek. schmett., 109 (1816).	Type.— <i>Papilio malvae</i> Linn.

Blumen halbverstothen blickten
Neckend aus dem Gras heraus,
Bunte Schmetterlinge schickten
Sie sogleich auf Kundschaft aus.

ETCHENDORFF.—*Auf meines Kindes Tod*.

Imago (58: 4). Head very large, especially broad, clothed with pretty long and very short hairs, the former mostly arranged in transverse lines; at the exterior base of the antennae, an appressed, strongly curving tuft of long, unequal hairs, directed outward and a little forward, reaching fully half way over the circumference of the eye. Front only a little full with a scarcely perceptible, blunt, transverse ridge at the middle and here only a little, elsewhere scarcely, surpassing the front of the eyes; separated from the vertex by a scarcely perceptible, straight line, uniting the bases of the antennae slightly in advance of their middle; front border nearly straight, slightly emarginate, the front lateral angles rounded off but not so much as usual, leaving the sides themselves nearly straight and striking the outer limit of the base of the antennae; about two and a half times broader than long, slightly hollowed in the middle above by a depression common to it and the vertex; the latter fully half as long again as the front, separated from the occiput by a nearly straight, scarcely perceptible line, behind the middle with a scarcely elevated transverse ridge formed of two similar arcs opening backward, the whole vertex slightly tumid throughout, but scarcely, if at all, elevated beyond the level of the eyes, locally very slightly tumid behind the interior base of the antennae. Eyes large, pretty full, nearly circular, naked, the unfaceted belt as

broad as the base of the antennae. Antennae with the hinder edge of the base a little in advance of the middle of the summit, their interior bases separated by two and a half times the diameter of the antennal base; the whole antenna nearly as long as the abdomen, composed of 36 (♂) or 33 (♀) joints, of which 17 (♂) or 16 (♀) form the club, which is a little more than one-fourth of the whole antenna, bent in a curve a little beyond its origin at much more than a right angle; it increases rather rapidly and regularly in size as far as the bend and then continues of the same width, equal to the length of four consecutive joints, the last four joints rapidly diminishing to a well rounded, somewhat conical tip; the whole club is compressed from in front and a little downward, backward, flattest in front; the joints in the middle of the stalk are about two and a half times longer than broad. Palpi comparatively slender, nearly twice as long as the eye, very heavily clothed with a loose mass of very long hairs and scales, out of which the small apical joint, clothed only with recumbent scales, protrudes by its tip only, but the looseness of the clothing of which permits of seeing the whole; basal joint small, globose, broader than long, very full anteriorly at the tip, where it is very nearly as broad as the broadest part of the middle joint, rather more than one-third the length of the middle joint; middle joint tumid, cylindrical, straight, fully two and a half times longer than broad, the base broadly rounded, the tip subconical, the apical joint perched on its summit, and inclined a little forward; last joint minute, slender, subovate, three and a half times longer than broad, its length about three-fourths the length of the middle joint.

Prothoracic lobes small, appressed, laminate, the edge channelled; viewed from the front pretty regularly ovate, its height nearly two-thirds its breadth, the lower outer edge largely and roundly excised, the length about two-thirds the diameter of the eye. Patagia large, broad, the posterior lobe as long as the rest, broad, scarcely tapering, broadly rounded at tip, about three times as long as broad, the whole piece as long as the space between the hinder edge of the eyes.

Fore wings (41:9) triangular, less than twice as long as broad, the inner margin distinctly longer than the outer; costal and inner margin straight, the outer margin gently and regularly arcuate. Costal margin thickened in its basal half or less, the costal nervure terminating about halfway between the middle of the wing and the end of the cell; first, second and third superior subcostal nervures equidistant, parallel, the first arising opposite a point midway between the first and second median nervures, and nearly at two-thirds the distance from the base to the apex of the cell; the fourth superior subcostal nervure, which strikes the apex of the wing by its apical arcuation, arising just before the tip of the cell, midway between the origin of the third and the basal angle of the inferior nervure which is subobsolete; the vein crossing the cell is marked only by the incensation and angulation of the opposing nervures; second median nervure arising opposite a point midway between the base of the second and third superior nervures, and the first median nervure a little nearer the base of the wing than the last; internal nervure slight, straight, upturned toward its tip, which ends in a mere thickening of the membrane.

Hind wings rounded, triangular, the costal longer than the inner margin, the upper outer angle subrectangular, the anal angle broadly rounded, the outer margin varying considerably in different species, but in all more or less and pretty regularly arcuate; inner margin moderately arcuate; the basal lobe of the costal margin is larger than in the allied genera; the relation of the costal, subcostal and median nervures and their veins are almost precisely as in *Pholisora* and the cross vein is indicated only by a slight spur on the opposing nervures, indicating that it is parallel to the outer margin; internal nervure only a little shorter than the submedian.

Scales enclosed in the costal fold of the fore wing of the male of two sorts: one well rounded, very long ovate, the other distally tapering, apically flagellate; sometimes other kinds are added.

Legs 2, 3, 1, clothed as in *Thanaos*. Femora 2, 1, 3 (♂), 2, 3, 1 (♀); tibiae 2, 3, 1; tarsi, 2, 3, 1; fore femora scarcely longer than the hind in the ♂, scarcely shorter than they in the ♀, in either about two-thirds the length of the middle pair; fore tibiae

fully two-thirds as long as the fore femora or the hind tibiae, and a little more than half as long as the middle tibiae; foliate appendage of fore tibiae long and slender, attached a little beyond the middle of the joint, extending somewhat beyond it, five or six times as long as broad, thicker above than beneath, equal excepting the curving apical third, which tapers to a rounded tip; hind tibiae of male sometimes furnished with a basal pencil of hairs; middle and hind tibiae furnished at tip beneath with a pair of long and very slender spurs, the hind tibiae with a subsidiary pair, exactly similar, in the middle of the outer four-fifths; hind coxae of male sometimes supplied with a special subcorneous appendage. Tarsal joints 1, 2, 3, 5, 4, the terminal longer than the penultimate joint; fore tarsi three-quarters the length of the other pairs, of the same length as the middle tibiae, all with a triple row of long delicate spines beneath, the terminal ones on each joint a very little longer than the others. Claws small and delicate, tapering very strongly and pretty regularly arcuate; pal moderately large, a little transverse; paronychial very slender, ribbon like, fringed beneath, tapering, nearly half as long as the claws.

Upper organ of male abdominal appendages having the centrum small, broad, almost depressed; hooks consolidated into a single prominence as long as the centrum; lateral arms extending backward horizontally as a triangular, pointed lamina. Claspers rather large, simple, a little convex, two or three times longer than broad and nearly equal; the upper lobe large and broad, not very high, separated from the parts beyond by a pretty deep notch, the apex of the blade rounded off, sometimes bearing above distinct dentations.

Egg. According to notes furnished by Prof. E. A. Popenoe the egg of *H. tessellata* is nearly spherical, flattened at base, with a very large number of vertical ribs.

Mature caterpillar. Head appressed globular, somewhat broader than high, of nearly uniform depth, twice as high as deep, the two hemispheres with scarcely independent arcuation above; the frontal triangle extending more than halfway up the front, half as high again as broad, equal on the lower half, arched above; inner triangle much smaller, more regularly triangular; the surface of the head so strongly and closely punctate with moderately large punctae as to be subrugose, excepting posteriorly where it is smooth. Pile composed of branching hairs. Epistoma broad, equal; labrum very short, forming a broad, arcuate piece, with a broad, considerable, median excision. Ocelli six in number, four anterior ones placed in a shallow arcuate row at subequal intervals, the third from above the largest, the lowermost close beside the antennal socket; of the two remaining, the upper and smaller is posterior to the uppermost of the arcuate row, and as far removed from it as the former is from a point midway between the two middle ocelli of the arcuate row; the lowermost is posterior to the third of the arcuate row, and is distinct from it as far as is the uppermost of that row. Antennae with the third joint cylindrical, about two and a half times longer than broad, the bristle twice as long as it. Mandibles stout, thick, laminate, tapering, more than half as broad at tip as at base, truncate, chisel-edged.

Body slender, largest at the fifth and sixth abdominal segments, tapering forwards very gently, excepting on the thoracic segments, where it more rapidly becomes narrower, though still by slow degrees, tapering posteriorly with greater rapidity, the last segment being much narrower than the preceding, narrowly rounded apically; first thoracic segment with a short, anterior neck, constricted to nearly half the width of the head, the posterior portion of the segment with a narrow dorsal shield extending from spiracle to spiracle; posterior half of each of the abdominal segments broken up into three subequal transverse sections, and another similar one imperfectly set off from the otherwise uniform anterior half of the segment in advance of them. Body completely covered with minute papillae arranged in single, transverse rows, one each on the short, transverse sections, but with entire irregularity on the anterior half of the segments; some of these are arranged in definite longitudinal series of which one consists of a laterodorsal row in the middle of the anterior half of each segment, and these are somewhat larger than the average and support hairs twice as long as they, but all support otherwise similar, slender, apically expanding hairs. On all the

abdominal segments there is a suprastigmatal series of crateriform annuli less than a third as large as the ordinary spiracles and situated directly over them, generally circular, but sometimes transversely oval. Legs slender, arcuate, tapering; the claws of a similar shape; prolegs short, moderately stout. Spiracles round oval.

Chrysalis. Head and prothorax together less than twice as broad as long, forming a quadrangular mass well rounded at the corners, the central half roundly and considerably protuberant in front, the width of the whole apparently not much less than that of the thorax; prothoracic spiracles large, tubercular, short, semilunate, laterally projecting beyond the limits of the prothorax, posterior lip strongly produced, crenulate, the whole interior filled with a rounded mass of short bristles. Position of the mandibles marked by no tubercle whatever, but the front at their tips very bluntly and broadly triquetral. The movable abdominal segments scarcely ridged at all, no ridges being perceptible when the are closed. Preanal button obsolete, the position marked by converging striae on a tumid field, but a latero-ventral ridge reaches forward from the lower outer angle of the cremaster, enlarging as it goes, until it dies out before reaching the eighth abdominal segment, which is barely marked off from the ninth; viewed from above the cremaster is equal, less than twice as long as broad, well rounded at the tip; from the side it tapers gently, and is nearly straight but slightly curved. Description from a specimen contracted in alcohol, sent by Prof. E. A. Popenoe.

This group, one of the most numerous in species among the Hesperidae, finds its maximum of development in the north temperate regions of the Old World; most of the species found in North America are confined to the western part, whose fauna bears a closer resemblance to that of the Old World than it does to that of eastern North America. In the Old World it extends from the polar region, or about 60° N. Lat., nearly to the thirtieth degree and in the Alps is found to the height of 7200 feet. In the New World it extends on the east coast, including the Antilles, at least from below the equator to the 55th degree and on the western coast nearly as high. Species from the southern part of the African continent have also been referred to this group and they are no doubt closely allied; in any case it is one of the most widely distributed genera of Hesperidae, a fact in accordance with the diversity of forms which compose it. It is the only genus of Hesperidae which is well represented in Europe and it is almost wholly absent from New England. Indeed it never has been captured within its political boundaries, although two species have been taken just without its limits. One of these species descends from the high north, where it is common to both sides of the Atlantic, while the other is very abundant in the southern states and reaches to the tropics. No other species are known in North America, east of the Mississippi.

The butterflies are of small size and may readily be distinguished by their checkered markings of white upon a dark brown ground—markings which are generally disposed in transverse series, especially across the middle and outer half of the wing, but so diversified in the numerous forms which compose the group as to render it difficult to describe the pattern; the under surface of the hind wings is particularly variegated, lacking the regularity

of markings of the other parts, different shades of brown, olive and yellowish green serving to enliven the general design, while an interrupted fringe to all the wings adds to their tessellated appearance.

The butterflies of this genus are either single, double or triple brooded, but all whose transformations are known are said to pass the winter in the chrysalis state. The butterflies fly in dry meadows and on sunny declivities, visiting flowers and sipping the moisture from the muddy soil in company with Rhodoceri; on alighting they expand their wings broadly; yet not always, for, approaching the genera of the following group, they often raise the fore wings higher than the hind pair, bringing the former at right angles to each other while the latter are horizontal; when at complete rest the wings are closed. The caterpillars live much after the manner of those of *Thanaos*, in nests constructed of their food plant; the European species live on various gamopetalous and polypetalous plants, especially Rosaceae (*Rubus*, *Potentilla*, *Fragaria*, *Comarum*, *Poterium*, *Agrimonia*), Labiatae (*Phlomis*, *Marrubium*) and Malvaceae (*Malva*, *Althaea*), but also on Compositae (*Carduus*), Polygalaceae (*Polygala*) and Plantaginaceae (*Plantago*). One of our species lives, so far as known, only on Malvaceae; the same according to Grundlach, is the food of a closely allied species from Cuba. Probably the Labrador species feeds on some labiate plant.

The caterpillars are slenderer than those of *Thanaos*, with a similar head and collar, green in color, with very slight markings. The chrysalids are darker than the caterpillars and slenderer than in *Thanaos*.

This account has been based on the assumption that the European and North American species placed in this genus in Kirby's catalogue are congeneric. A study of the caterpillars of some of them and of others in neighboring genera, however, shows me that this is positively not the case, and that a revision is necessary which will compel a further disintegration of the tessellated Hesperidae of Europe.

EXCURSUS LIX.—ANOMALIES IN THE GEOGRAPHICAL DISTRIBUTION OF OUR BUTTERFLIES.

... The mute insect fixed upon the plant
On whose soft leaves it hangs, and from whose cup
Draws imperceptibly its nourishment,—
Endeared my wanderings.

WORDSWORTH.—*The Excursion.*

AN unusual amount of detail for a work of this class has been given in the present volume to the geographical distribution of the butterflies, and every effort has been made to obtain authentic data, mainly from an examination of specimens themselves from known localities, but also by collating data given by others (eliminating such as seemed really doubtful) in

order to fix for each species its probable range. The plotting of these localities upon maps brings these facts more vividly before the eye and permits a readier comparison; but in addition to that it brings out in full relief some striking anomalies in the distribution. Doubtless in most cases these anomalies can be referred to imperfect knowledge, since they often only extend further in an isothermal direction the well known range of the species; but in other cases it is difficult to account for the presence of a given form so far removed from all its other known habitats.

As an instance of the former class may doubtless be cited such a species as *Oeneis jutta*, which is known from localities as far apart as the Rocky Mountains of British Columbia and Hudson Bay, but from no part of the intervening area; in this instance the known localization of the butterfly is morasses of peculiar nature sufficiently accounts for its not having been found in the country lying between these two points, where it would seem from its presence in the Rocky Mountains that it must unquestionably exist. But quite another matter is the discovery of *Cereyonis nephele* in the Athabasca region bordering Hudson Bay, when it has not been found in any of the intervening area between this and southern Manitoba, where not a few collections have been made which would be likely to contain so easily captured and striking an insect. Or, still better, observe the case of *Satyrodes eurydice*, a species which, but for a single capture in the far northwest by Great Slave Lake, would be unknown excepting in the north-eastern United States and the parts of Canada adjoining; here the species has been discovered a thousand miles from the western limits of the previously known range.

We have taken these examples entirely from one limited group, the Satyrinae. What is true of them is true also of numerous other species, to mention a few of which in serial order, we call attention, first, to the extraordinary fact of the occurrence of *Polygonia satyrus* along the valley of the St. Lawrence in two or three different localities, when it had previously not been known east of the Rocky Mountains. *Junonia coenia* is even a more startling case, for it has been taken in a single instance north of our boundary in the Rocky Mountain region, whereas, by its previously known distribution, it was justly looked upon as a southern butterfly, its nearest point to this capture being central California, at least six hundred miles away. The occurrence of each of our New England species of *Argynnis* in distant parts of the Rocky Mountain region, north and south, is explainable by the fact of the extension of each of these species nearly or quite as far as the eastern limits of this region, or at least to the western borders of the prairie region, and it may perhaps be questioned whether in all these instances the species be rightly determined.

In *Hypatus bachmanii* we have an instance of a different nature, not so striking perhaps, for we have to deal with an insect remarkable for its

sudden outbursts of abundance, and it is probable that its occasional occurrence in regions where it has not previously been known is due to the rapid distribution of such sudden outbursts; thus, while it is rarely found in any numbers north of West Virginia, it has appeared in several instances at some distance to the north, though these distances cannot be compared to the extraordinary gaps which intervene in the case of other species. One of these is *Erora laeta*, concerning whose distribution we have clearly much to learn; it had been taken only on one or two occasions in single specimens, at somewhat widely distant localities, usually in elevated regions in the north-eastern United States, when suddenly it was discovered in great abundance in southern Arizona, thousands of miles away. It is difficult to discover how these widely separated regions may be connected and at the same time to explain why so striking and lovely a butterfly has escaped the notice of collectors in the intervening regions; this is indeed one of the most extraordinary instances we have, and may perhaps be partly explained by the fact of the small size of the insect, since we have several instances in the same tribe of butterflies of almost equal moment; thus *Incisalia irus*, as far as we at present know, is an inhabitant almost exclusively of the eastern half of the continent and of the middle section of the United States excluding its northern and southern portions; but apparently the same species has now been discovered in tolerable abundance on Vancouver's Island. Or consider its ally, *Incisalia nippon*, known only from New England and the regions immediately about it, with an extension down the Alleghanies, but which has also been found in central Texas and central Colorado, regions where collectors are of course much more scarce than in the intervening districts.

A partial explanation may perhaps be offered by the distribution of *Incisalia augustus*, which, occupying in the east a region very similar to that of *Incisalia nippon*, has also been found in Colorado and the region to the west of it, but which we also know extending in a narrow belt across the country north of our boundaries; it is in the highest degree probable that in the same belt the other species may be found when these have been properly searched at the appropriate season. A similar explanation may perhaps be given for the distribution of *Thecla calanus* and *Thecla acadica* as plotted upon our maps, which are known both from the extreme east and the extreme west but have not been taken in sufficient number in localities in the Rocky Mountain and elevated plateau regions properly to connect these two apparent colonies. Or for that of *Thecla edwardsii*, which occurs in a narrow belt from the Atlantic to the Rocky Mountains along the 40th parallel or thereabout and has been found in a single instance ten degrees farther north above the westernmost known area of its distribution; and it explains also, perchance, why we know so little of the distribution of *Thecla ontario*, which is so exceedingly

scarce that hardly a dozen examples are extant, taken in southern New England and southern Ontario; it is a well marked species and possibly has been overlooked by its close affinity to some of the neighboring kinds. The known local habits of *Chrysophanus thoe* and *Epidemia epixanthe* will perhaps sufficiently explain their apparent absence from the little explored regions of the Canadian northwest, except in one or two localities a thousand miles apart. Search at the proper season in the proper spots in the intervening region will doubtless vastly extend our knowledge of their distribution.

It will thus be seen that all the anomalies of distribution which are here brought together appear to have their origin in insufficient knowledge. They indicate that one of the most important regions for exploration is that which lies along the boundary line between the United States and Canada in the central parts of the continent, where more than elsewhere it is probable that a bridge will be discovered, giving connection between the colonies now known to exist upon the east and the west, and not in the intervening area.

More particularly is it true that insufficient knowledge must account for apparent anomalies when we come to examine the *Hesperiidae*, a group to which so little attention has been given and where identification has been in many cases not altogether clear; that we have here much to learn is very clear from our maps. *Thanaos lucilius*, known abundantly in southern New England and an equivalent region west of it, is brought also from distant Dakota and Georgia, but is not known in the intervening regions. *Thanaos persius* has an immense distribution across the continent, but is altogether unknown from the Mississippi valley, excepting its northern portions, and yet occurs in central Texas. *Pamphila mandan*, found north of our boundaries in the eastern portion of the Dominion of Canada has also been taken in so many different points in the elevated region upon the west coast from Nevada to Alaska that it will unquestionably be found throughout the Dominion of Canada northwest of Lake Superior. In the species of *Amblyscirtes* we have greater difficulties to deal with. *A. vialis* is known northeast of a line stretching from Georgia to Montana, but is not known west or south of that line, excepting in central Texas and northern California; and so *A. samoset*, evidently a more northern form, found in a northern belt of country following in the main the valley of the St. Lawrence, but extending west as far as Iowa, also occurs in considerable abundance in the uplands of Georgia, leading us to suppose that it stretches southward along the Alleghanies. *Euphyes verna*, a species almost entirely confined to a relatively narrow belt along the fortieth parallel east of the Mississippi, has been taken in the Canadian northwest a thousand miles away from its nearest neighbor; so, too, the other species of *Euphyes*, *E. metacomet*, which covers almost the entire northern half of

the United States east of the Rocky Mountains, is found again upon the Pacific coast, but not as yet within the intervening area. *Thymelicus brettus* is a different kind of instance, being known only along the seaboard, excepting in a single instance west of Lake Michigan. *Limochares manataqua* represents a case extremely similar to that of *Euphyes verna*, occupying the same area in the east and found again at the same locality in the west. The repetition of these cases plainly indicates a direct connection between the two widely separated areas.

But perhaps the most striking instance of all, with the possible exception of *Erora lacta*, is that of *Hesperia centaurea*, and it is the more striking from the fact that it is a checkered butterfly which no one could possibly overlook, as entirely different from anything else found in the regions where it occurs. This butterfly, which is an inhabitant of extreme northern Europe, was for a long time known on this continent only from the eastern coast of Labrador, when it suddenly turned up thousands of miles away in the mountains of West Virginia, and within the last twenty-five years or more has been found at several localities in the intervening area,—at Washington, Long Island and the northern borders of Vermont, the first two on low lands, and yet at immense distance from its true subarctic home.

We have here referred only to the anomalies in the known distribution of the living butterflies themselves, for space does not permit more than an allusion to the fact that the mere presence of certain butterflies having their main affinities in far distant quarters of the globe is itself the greatest of anomalies; but here we evidently touch upon questions into which geological time enters as an important element and the consideration of which might lead us too far afield.

Table of the species of Hesperia, based on the imago.

Extramarginal white band of upper surface of wings composed of subcontinuous spots, each of which is much broader than, generally at least twice as broad as, high; hind tibiae and hind coxae of males with no special appurtenances.....	<i>montivaga</i> .
Extramarginal white band of upper surface of wings wholly discontinuous, the spots no broader than high; hind tibiae of males with a basal pencil of very long hairs, and hind coxae with a long, cylindrical, posteriorly directed, subcorneous process, densely covered with short hairs.....	<i>centaurea</i> .

The early stages of one of the two species being wholly unknown, no further tables can be constructed.

HESPERIA MONTIVAGA.—The variegated tessellate.

[Black and white skipper (Abbot); the Georgian grizzle (Haworth); checkered *Hesperia* (Grote).]

Pyrgus montivagus Reak., Proc. acad. nat. sc. Philad., 1866, 334 (1866).

Hesperia tessellata Scudd., Syst. rev. Am. butt., 52-53 (1872).

Pyrgus tessellatus Hew., Cat. coll. diurn. Lep., 231 (1870);—French, Butt. east. U. S., 352-353, fig. 86 (1880).

Syrichthus communis Grote, Can. ent., iv: 66-70 (1872).

Hesperia alborittata Grote, MS. (Cf. Bull. Buff. soc. nat. sc., i: 168—1873).

Papilio syrictus Abb., Draw. ins. Geo. Brit. Mus., vi: 78, figs. 110-112 (ca. 1800).

Pyrgus syrictus Streeck., Cat. Amer. Macrolep., 176 (1878).

Papilio oileus Haw., Trans. ent. soc. Lond., i: 334 (1812).

Syrictus oileus Morr., Syn. Lep. N. A., 121 (1862).

Papilio — Abb., Draw. ins. Geo. Brit. Mus., xvi: 54, tab. 137 (ca. 1800).

Also figured by Abbot, Draw. ins. Geo. Gray coll., Hist. soc. nat. hist., 61;—Glov., Ill. N. A. Lep., pl. 19, figs. 9, 11 (?); pl. 29, fig. 12; pl. U, fig. 4, ined.

[Not *Pap. oileus* Linn.; nor *Pap. syrictus* Fabr.]

With a step and a bound,
With a frisk from the ground,
I'll trip like any fairy.

As once on Ida dancing
Were three celestial bodies:
With an air, and a face,
And a shape and a grace,
I'll charm, like beauty's goddess.

D'URFEY.—*The Lady distracted with Love.*

A butterfly basked on a baby's grave,
Where a lily had chanced to grow;
"Why art thou here with thy gaudy dye,
When she of the blue and sparkling eye
Must sleep in the churchyard low?"

Then it lightly soared thro' the sunny air,
And spoke from its shining track;

"I was a worm till I won my wings,
And she whom thou mourn'st, like a seraph sings,
W'dst thou call the blest one back?"

SIGOURNEY.

Imago (15:9). Head covered above with bluish gray hairs, with some intermingled black ones, especially across the middle; beneath covered with white scales, which extend in a narrow belt behind the eyes, becoming a little yellowish above, interrupted narrowly a little behind the antennae, but extending to the middle of the front; tuft of hairs outside of antennae black. Palpi white, with a few delicate black hairs scattered throughout, but more abundant toward the apex, where they form a distinct annulus around the base of the apical joint, heaviest above; apical joint black, heavily flecked or wholly covered with white beneath. Antennae black or blackish brown, interrupted narrowly above, at the base of all but six or eight of the basal joints, and including also the joints of the club, with white; the whole under surface and also, on the six or eight basal joints, the anterior surface continuously white, tinged with nacreous, including the basal fourth of the club; rest of under surface of club and whole of its apical joint naked and dark castaneous.

Thorax covered above with bluish gray hairs, becoming brownish gray posteriorly; beneath with white hairs tinged slightly with dirty yellow. Legs nacreous white, the fringe of femora mostly white but with intermingled black hairs; sides of the femora often flecked with brown; the front of the tibiae, excepting of the fore legs, and of all

the tarsi, tinged generally with brownish, occasionally distinctly chocolate brown; spurs white, at tip dusky reddish; spines luteous; claws varying from luteous to dark reddish.

Wings above blackish brown, slightly tinged with ferruginous, largely checkered with white. Fore wings with the basal two-fifths of the costal margin, the middle of the basal half of the cell, the basal half of the medio-submedian interspace, especially above, and the inner border as far as the submedian nervure, excepting the apical fifth, covered abundantly with not very long, bluish gray hairs, more abundant and conspicuous in the ♂ than in the ♀; the costal edge, excepting the extreme base in the ♂ and the basal one-third or two-fifths in the ♀, is white, interrupted rather broadly with dark brown at the nervule tips. Above the subcostal nervure and inferior subcostal nervules, the outer four-sevenths of the wing is largely flecked with longitudinal white dashes, mostly arranged in three transverse series of three or four spots each, separated by the nervules, larger and more conspicuous in the ♂, where they are nearly confluent than in the ♀: the innermost series consists of three oblique dashes, the middle one much larger than the upper and occupying the basal two-thirds or three-fourths of the interspace between the first and second superior subcostal nervules; the lowermost is usually reduced to a mere dot, and is not infrequently absent; the middle series consists of four nearly equal, shorter, generally wedge-shaped dashes, in a series nearly at right angles to the costal border, the uppermost occupying the middle of the interspace between the second and third superior subcostal nervules, the other three at the extreme base of the succeeding lower interspaces; the three spots of the outer series are in the same interspaces, separated by but a narrow space from the middle series and occupying the whole width of the interspaces, are broader than the preceding and subquadrate, with rounded corners; the uppermost is often accompanied, especially in the ♂, by a minute dot just beyond its outer extremity. In the cell and the interspaces lying beyond it, including the upper median interspace, these series are continued as two sets of white spots: the innermost, of about equal size in ♂ and ♀, is quadrate, usually simple and squarish, sometimes partially or wholly divided into an upper and lower; it crosses the cell close to its extremity, its upper outer angle usually lying opposite the middle of the space between the base of the second and third superior subcostal nervules; the outer series consists of three spots, one in each of the interspaces, always larger and more distinct in the ♂ than in the ♀, situated in a transverse series, their inner edges as far beyond the extremity of the cell as the outer border of the cellular spot lies within it, and when fully developed, they extend half way to the outer border, at least below; in the ♀ they are often reduced to mere cloudy dashes in the middle of the interspaces, but in the ♂, although separated by the nervules only, they are at least twice as long as broad. This series is in direct continuity with the middle of the three superior series; the upper half of the space between the two series of the middle of the wing is usually occupied, at least in the ♂, by two white dots, the upper the larger; below the middle median nervule, this field is occupied by but a single transverse series of three spots, the two in the medio-submedian interspace occasionally merged into one; it runs subparallel to the outer border, is directed between the two median series, and is of about the width of the outer of them, generally much more conspicuous in the ♂ than in the ♀; the upper spot is quadrate, generally twice as long as broad, and the largest spot in the wing; the two spots below are usually separated only by a line, subquadrate, but variable and often quite irregular in outline; within these, at the extreme base of the lower median interspace, is a small, triangular spot, occasionally obsolete, and usually, and as often in the ♀ as in the ♂, accompanied by a small quadrate spot, seated on the submedian nervure, below the base of the lowest median nervule. The outer portion of the wing is provided with a slightly tortuous, submarginal series of subequal, roundish, occasionally quadrate or even sublunate spots, eight in number, two of which are in the medio-submedian interspace, and one in each of the succeeding interspaces above, usually at slightly more than an interspace's distance from the outer border; from above downward they regularly approach the outer border as far as the

lowest subcostal interspace, retreat from it and again return toward it in the upper median interspace, and then regularly recede from it again; the two upper spots and that in the upper median interspace are nearly always smaller than the others, and in the ♀ are often reduced to mere dots; following these, and in the same interspaces, occasionally wholly or partially obsolete, especially in the ♀, is a series of delicate, very short, longitudinal lines, seated on the black edged margin and surmounted by a slightly larger dot; occasionally these are blended to form a series of minute triangles, seated on the margin, which is always narrowly edged with black; fringe white, interrupted abruptly, distinctly and not very narrowly with blackish at the nervule tips, often more broadly in the ♀ than in the ♂, and in the former occasionally obscured by brownish. *Hind wings* having the lower half of the wing, excepting the inner margin, covered with long, longitudinal, greenish gray hairs, especially next the nervures, the longest next the submedian nervure; an arcuate, unequal band of white spots crosses the middle of the outer four-fifths of the wing, extending from the costal nervure to the middle of the medio-submedian interspace, broader and far more conspicuous in the ♂ than in the ♀; above the upper median nervule it is of about equal width, the largest spot, in the middle of the wing, running from the last divarication of the subcostal and median nervures nearly or quite half way to the outer border; below, it is of half the width, removed a little further inwards, at least below the middle median nervule, and generally tapers a little as it proceeds. A small, obscure spot is sometimes seen in the middle of the upper half of the cell; there is a submarginal series of six or seven roundish spots below the upper subcostal nervule, subparallel to the outer border, but approaching it a very little more closely beyond the cell than elsewhere, often reduced to dots in the ♀, and usually about an interspace's distance from the border; these are accompanied by a series of six dots seated on the margin, the spot in the lower half of the medio-submedian interspace having none; some or all are sometimes absent from the ♀; the margin is delicately edged with black; fringe white, the basal half, occasionally the whole, narrowly and abruptly interrupted with blackish at the nervule tips.

Beneath: *Fore wings* much paler brown than above, often faintly tinged with olivaceous; the white markings of the upper surface are repeated but on a slightly enlarged scale, so that especially along the costal area they become partially or even wholly confluent, with only dusky nervules to break the uniformity; the upper half of the basal two-fifths of the wing is also more or less bathed in white, and the apex of the wing, beyond the triple series of subcostal spots, is clouded with olivaceous, followed below, as far as the upper median nervule, by a white patch; the outer border is delicately edged with black, and more distinctly dotted in the middle of the interspaces, to which indeed the outer edging is occasionally confined; fringe much as above but the blackish interruptions usually somewhat fan-shaped, spreading from the border. *Hind wings* varying from greenish clay brown to a simple pale brown like that of the fore wings, but usually more or less tinged with greenish; the white markings of the upper surface are repeated beneath, more or less distinctly edged with black—generally with varying intensity—the mesial band broader and continuous, extending from the costal nervure to the submedian; the submarginal spots are accompanied by smaller, cloudy white, marginal spots, occasionally blending with the submarginal series; in addition, midway between the mesial band and the base is a narrow, whitish, irregular, transverse, externally black edged stripe, farthest removed from the base in the costal-subcostal interspace and there edged also internally with black; the costal and inner margins as far respectively as the costal and submedian nervures are dull whitish, usually powdered, particularly on the inner margin, with dusky scales; on the costal border there is a small, transverse, blackish bar at the extreme base and another shorter, but little removed from it, often connected along the margin by a blackish line so as to make a virgulate mark; on the inner margin the dusky flecking becomes intensified next the outer margin and forms a fuliginous spot, sometimes the only marking on the margin; outer margin edged and dotted with black like the fore wings, the fringe as on the upper surface.

Abdomen blackish brown on the upper half, the extreme apical edge of the segments marked with white especially on the sides; beneath white, tinged on the sides with greenish yellow, the apical segment wholly greenish yellow below, the black hairs of the upper surface yellow-tipped. Upper organ of male appendages (35: 39, 40) with the hook regularly triangular, half as long again as broad and as long as the centrum, straight, depressed, laminate, nearly horizontal, carinate along the middle; lateral arms almost entirely similar, parallel and distant, extending quite as far back. Clasps two and a half times longer than broad, equal on the basal half, rapidly narrowing by the excision of the upper border in the next quarter, thus forming the somewhat angulated upper lobe, and beyond directed abruptly upward and forward, terminating higher than the upper lobe in two triangular pointed teeth, the posterior the larger, formed by the angular excision of the extremity.

Measurements in millimetres. Length of tongue, 8 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	13.5	15.	16.	14.25	16.25	17.
antennae.....	5.5	5.75	6.5	5.85	6.75	7.
hind tibiae and tarsi..	5.3	5.75	6.5	5.85	7.25	7.9
fore tibiae and tarsi..	4.	4.5	4.5	4.2	4.5	4.8

Described from 27♂, 18♀.

Accessory sexual peculiarities. The costal fold of the fore wing of the male contains some flagellate androconia which are moderately stout, equal at base, taper only near apex and terminate in a flagellum nearly as long as the lamina (48: 4 a); the other androconia are long oval with parallel sides, of two lengths but similar widths, some as long as the flagellate scale with its flagellum, or about .16 mm. long (4 b), some smaller than the lamina of the same (4 c), or about .06 mm. in length; the cover scales are very large, irregularly oval (4 d).

Egg. Nearly spherical, flattened at base, with twenty-four prominent vertical ridges radiating from the summit. Color white, with nacreous reflections; width, .5 mm. After a description received from Prof. E. A. Popenoe.

Caterpillar. Last stage (77: 14, 17). Head (88: 45) uniform piceous, the glistening color subdued by the dense, short pile which consists of compound, branching, pallid, more or less infuscated, brownish hairs arising from the centre of one of the pits with which the surface is uniformly studded.

Body presumably green in life, of a pale testaceous color in blown specimens; all but the incisures and the papillae more or less infuscated, excepting along certain definite longitudinal lines, the papillae themselves being of the lightest color of the body, like the incisures. The longitudinal markings are as follows: a small, dusky spot, probably dark green in life, at the extreme anterior edge of the dorsal line, encroaching on the incisures on all the segments, but more marked in advance of the third abdominal segment than behind it; a faint, dusky, subcontinuous, dorsal line is thereby intensified, but on the largest segments is itself cut by a longitudinal, paler thread; the moderately broad, dark, lateral stripe running the whole length of the body, made much more conspicuous by being narrowly edged by supralateral and infralateral pale lines, the lower of which margins, as well, an interrupted laterostigmatal dark band, similar to, but far less continuous and conspicuous than the lateral band; a whitish, interrupted, ventrostigmatal stripe, most conspicuous on the apodal abdominal segments and especially at the anterior and posterior extremities of the segments, between which it is sometimes interrupted and where it sometimes widens into spots; first thoracic segment reddish brown, probably dark luteous in life, margined posteriorly with a moderately narrow band of black and infuscated anteriorly, the infuscation broken irregularly by pale yellowish along the median line; surface of the body finely and closely punctate. The first two pairs of legs and claws blackish fuscous; posterior pair of legs and prolegs concolorous with the under surface. Spiracles luteous; supralateral, crateriform annuli testaceous in a pallid spot, entirely similar to those in which the papillae are situated. Length, 15 mm.; breadth of second thoracic segment,

1.6 mm.; of fifth abdominal segment, 2.5 mm.; of head, 2 mm. Described from a blown specimen received from Mr. Riley.

Prof. E. A. Popenoe has kindly sent me the following description of the living full-grown caterpillar, taken by his assistant Mr. Marlatt:—"Head, first [thoracic] segment, first two pairs thoracic feet brownish black; head darker than first [thoracic] segment, and thickly covered with yellowish hairs. Body greenish, thickly armed with short, whitish, knobbed hairs; it tapers posteriorly, and is thickest in middle segments. Two broad, whitish, dorsal lines, and two lateral lines, all indistinct. Stigmata yellowish. Abdominal feet tipped with yellow-brown. Length, 17 mm."

Abbot's painting (77:17) shows the head brownish-black; the body pale, yellowish green, the sides with a very broad, pale band, enclosing in the middle an interrupted, slender, rather dark green stripe; a faint, darker green stigmatal line; whole body covered with greenish yellow hairs, which are tolerably conspicuous; first thoracic segment reddish, with longitudinal, broad, whitish patches on the anterior half; legs dark; prolegs green. Length, 30 mm.; height, 4.25 mm.

Chrysalis (85:35). Dark green, heavily marked with dark, reddish brown, the prothorax being margined with it, the antennae and legs heavily marked, and the wings longitudinally and rather extensively streaked; the abdomen is also furnished with longitudinal rows of small spots of the same situated near the sutures, and arranged apparently in laterodorsal, suprastigmatal and infrastigmatal series; a moderately broad, stigmatal band is free from them. Length, 20 mm.; height, 5 mm. Described from Abbot's painting.

The following description was received from Prof. E. A. Popenoe, the only one yet taken from life, so far as I know:—"General shape of pupa of this subfamily. Body yellowish white, eyes reddish, red lunar spots at prothoracic suture; cremaster reddish, much elongated and armed with curved or clubbed reddish spines. Body including head and eyes thickly covered with whitish hair; dorsum dotted with black, arranged on the segments in two transverse rows. 15 mm. long."

Comparisons. The Cuban species *H. syrichtus*, certainly closely allied to this, differs from it in being decidedly more uniform in markings in the earlier stages, as may be seen by the following descriptions which I have drawn up from notes given me by Dr. Gundlach, and his printed descriptions and those of Dewitz.

The head of the caterpillar is brownish black, rough with fine white hairs. The first thoracic segment is ferruginous with two ochreous longitudinal stripes on either side; the rest of the body is green with scarcely distinguishable bright points, and covered with very many short, white hairs apically enlarged, situated on the middle of the subsegments. There are scarcely distinguishable dorsal, laterodorsal and stigmatal stripes of a slightly darker green. The thoracic legs are brown with black claws.

The *chrysalis* is pale green with a brownish tinge above, clothed with many short, white hairs. The head is somewhat more olive, and the wings are tinged with orange, as is also the abdomen, and bordered next the spiracle of the fourth abdominal segment with fuscous. A lateral line of black points extending from the mesothoracic segment backward over the whole abdomen. The minute papillae supporting the hairs are black. Stigmata brown; the prothoracic stigmata large, swollen posteriorly margined with black.

Distribution (29:2). This butterfly belongs to the Carolinian fauna but is also very abundant in the southern parts of the Alleghanian. It is one of the commonest, if not the commonest, of the southern Hesperidae, and extends from the Atlantic to the Pacific. East of the Rocky mountains the northernmost points from which it has been specifically reported (excepting that it was found at Medicine Hat, Assiniboia, by Geddes) are at Heart River Crossing and the Big Muddy, Dak. (Allen), in Iowa at Ames (Osborn) and Davenport (Putnam, Austin), Wiscon-

sin, in some years abundant (Hoy), northern Illinois (Worthington), Essex County, Ont., several specimens (Lowe), Staten Island (Davis), and southern New York (Edwards). It has been found in considerable abundance in Maryland (Weidemeyer) and at Harrisburg, Penn. (Shurtleff), although it is said to be rare at Cincinnati, Ohio (Dury). In the Rocky Mountain region it has been taken in various localities in Colorado, where it is common at low elevations (Snow), in Montana (Coues) and Dakota (Morrison), in Utah at Salt Lake and American Fork Cañon (Scudder) and Summit Cañon (Packard), in southern Utah, especially St. George (Palmer), in New Mexico and Arizona (Snow), and at Truckee, Nev. (McGlashan). On the Pacific coast it occurs abundantly in all of southern California, but how far north it is found I have no means of saying. Besides its range throughout the southern United States, it extends into Mexico, at the border of which, in Texas, it is mentioned by Lintner and Aaron. I have seen specimens from Putta, 150 miles from Oaxaca in the tierra calida, and I thought I had formerly had them from Cuba, but an examination of all I now have from there proves them to be either *H. syrichtus* or *H. crisia*.

Its occurrence near the mouth of the Hudson gives it its only claim for introduction among New England butterflies.

Food plants. Abbot states that a caterpillar bred by him fed upon "wild tea," a species of *Sida*, one of the Malvaceae; Riley obtained the caterpillar figured in our plate from a species of *Malva*, and Prof. E. A. Popenoe obtained it on hollyhocks (*Althaea*) and Indian mallow, *Abutilon avicennae*, all members of the same family.

Life history, etc. It appears to be triple brooded in the extreme south, probably wintering as a chrysalis. According to Popenoe the eggs are laid on the upper surface of leaves. The very meagre data at hand lead me to conjecture that the first brood of butterflies appears toward the middle of April, and continues on the wing until June and part way through that month; the second, after twelve days in the chrysalis (Abbot), early in June, continuing to emerge until perhaps the middle of July and flying well into August; Popenoe reared one July 12 in Kansas after eight days in chrysalis; while the third and most abundant appears late in August and until toward the middle of September, flying through October. The full grown caterpillar has been found in September and November. It is therefore upon the wing from early spring until autumn, as Grote expressly says.

Abbot says it is to be met with in the oak woods and fields in Georgia and is not common there. Putnam says that in Colorado he found it flying swiftly up and down the roads close to the ground, and very difficult to capture. Abbot's caterpillar in pupation, "spun itself up in the leaves."

I have never in recent years seen the present species in nature, but the

closely allied *H. syrichtus* was noticed by me in Cuba as flying not very swiftly scarcely a few inches above the ground, and with less of the skipping movement than is common among the *Hesperidae*. When it alights in the sun, it expands the wings completely; when it first alights, the costal edges of the fore wings form a common straight line or they may be slightly advanced; when at more perfect rest, the fore wings nearly cover the hind pair, so that the costal margins of the former make an angle of about 135° with each other; the antennae then droop at an angle of about 45° with the body and spread at an angle of about 150° .

Desiderata. No facts concerning the distribution of this insect in the Alleghanian fauna, or west of the great plains, can fail of adding to our very meagre knowledge of the distribution of this butterfly. But what we most need are more details concerning the structure and markings of the insect in its early stages, for the egg and the earlier larval stages are almost entirely unknown, and the chrysalis imperfectly described. So, too, no one has attempted to trace its life history, and the sketch given here is only made up from scattered notes of capture; not a line has been written of the larval habits nor much of those of the butterfly. And yet in the south it is one of the commonest species and can be easily reared. We do not even know how the winter is passed, judging that it is in the chrysalis only by the analogy of its congeners which are said to do so.

LIST OF ILLUSTRATIONS.—*HESPERIA MONTIVAGA*.

General.

Pl. 29, fig. 2. Distribution in North America.

Caterpillar.

Pl. 77, fig. 14, 17. Mature caterpillars.

80:45. Front view of head, in fifth stage.

Chrysalis.

Pl. 85, fig. 35. Chrysalis.

Imago.

Pl. 15, fig. 9. Both surfaces.

35:39, 40. Male abdominal appendages.

41:9. Neuration.

48:4. Scales of male imago.

58:4. Side view, with head and appendages enlarged, and details of the structure of the legs.

HESPERIA CENTAUREAE—The grizzled tessellate.

Syrichtus centaureae Bois., Gen. ind. meth. Eur. Lep., 36 (1840);—Wallengr., Lep. Scand. rhop., 265-268 (1853);—Möschl., Wien. ent. zeit., viii, 193-195 (1864).

Hesperia centaureae Ramb., Faun. ent. Andal., ii: 315-316, pl. 8, fig. 10 (1840);—Herr.-Schaeff., Schmett. Eur., i, 155, pl. Suppl. figs. 1-3 (1843).

Scelothrix centaureae Ramb., Cat. syst. Lep. Andal., 78 (1858).

Pyrgus centaureae Edw., Cat. Lep. Amer., 50 (1877);—French, Butt. east. U. S., 353-354 (1886);—Schilde, Berl. ent. zeitschr., xxx: 53-55 (1886).

Hesperia caelinae var. *centaureae* Wern., Stett. ent. zeit., xxi: 68 (1861).

Hesperia veyandot Edw., Proc. ent. soc. Philad., ii: 21, pl. 5, fig. 4 (1863).

Figured also by Glover, Ill. N. A. Lep., pl. I, fig. 1, ined.

There is a sleep for all things. On still nights
There is a folding of a million wings—
The purple honey-bees in unknown woods,
The speckled butterflies, and downy broods
In dizzy poplar heights:
Sleep for innumerable nameless things,
Sleep for the creatures underneath the sea,
And in the Earth, and in the starry Air! . . .

ALDRICH.—Invocation to Sleep.

Imago (15:5). Head covered above with pale greenish yellow and brownish hairs, the former more abundant on the hinder, the latter on the front half; beneath very pale straw yellow, with a narrow belt of the same encircling the eye, brighter in color above and interrupted at the antennae, and again a little way behind them; tuft of hairs outside the antennae black. Palpi white, very faintly tinged with bluish yellow, pretty profusely supplied, excepting on the sides, with long, delicate, black hairs, which increase somewhat in abundance toward the tip, but there are as abundant below as above; apical joint blackish brown, heavily supplied with yellowish beneath. Antennae black or blackish brown, not so dark on the club and often tinged with yellowish brown, all the joints, including those of the club, interrupted with white on the basal third to half above; beneath wholly yellowish nacreous, deepest in color on the club, where it extends to the tip; apical half of the anterior portion of the club and the whole of the terminal joint naked and dark castaneous.

Thorax covered above with pale, dull greenish brown hairs; beneath with pale greenish yellow hairs, mingled with black ones on the coxae; in front dirty white; femora and tibiae blackish brown, very heavily flecked with silvery white and nacreous scales, the former fringed with long white hairs with a few intermingled black ones; hind tibiae of male with a spreading pencil of hairs longer than the tibiae, attached to the inner side of the base; hind coxae with a pair of parallel, backward directed, apparently cylindrical processes, as long as the tibiae and clothed with a mat of short hairs; tarsi luteo-castaneous, heavily flecked above and on sides with white scales, but mostly supplanted above, especially on the apical joints with brown. Spurs white tipped with dark reddish; spines reddish luteous; claws reddish.

Wings above very dark gray brown, with a barely perceptible olivaceous tinge, spotted with white. *Fore wings* profusely furnished at the base with pretty long, longitudinally directed, pale greenish gray hairs, which are also found very sparingly on all other parts of the wing, decreasing in abundance toward the outer border; the cell is marked at its extreme tip by a short, transverse line, and is crossed in the middle of its outer two-fifths by a rather narrow, usually bent or arcuate bar, opening outward; above the latter is a short longitudinal dash in the interspace between the first and second superior subcostal nervules and often a second above the upper of these nervules; a small spot, usually divided longitudinally in two, is found in the middle of the basal three-fourths of the medio-submedian interspace; near the middle of the outer half of the wing is a narrow, very tortuous, transverse series of nine subequal spots; it is composed of three portions: the upper consists of three rounded spots, generally longer than broad, depending at right angles from a point a little beyond the middle of the outer half of the costal margin, separated from each other by the fourth and fifth superior subcostal nervules; the middle series is a diagonal, nearly straight but slightly curving series of more distant spots, of which the second from above is smaller than the others and which lie in the succeeding interspaces, terminating at the lowest median nervule. In the direction of a line drawn from the outer margin in the middle of the upper of the two interspaces beyond the cell to the middle of the basal two-thirds of the inner margin; the lower series is parallel to the middle one and consists of two spots, generally a little smaller than those directly above, in the medio-submedian interspace, midway between the inner spots of same interspace and the outer border; the outer half of the costal edge is alternately and equally marked with white and blackish, the former forming four dashes, of which the second before the apex is directly above the extra-mesial series of spots; the outer border is sometimes indistinctly edged with black. Fringe whitish, interrupted conspicuously, but not very broadly, at all the nervure tips with the color of the wing, often expanding a little apically. *Hind wings* more or less deeply marked with two arcuate series of often obsolescent, always blurred, whitish spots, the broader crossing the wing just before the middle and scarcely discoverable on the lower half of the wing, the other of a breadth similar to the extra-mesial series of the fore wing, midway between the first and the outer border, approaching the latter slightly where it terminates below at the submedian nervure; outer margin seldom edged with blackish; fringe as in fore wings, but without any fan-like expansion of the dark interruptions.

Beneath paler brown than above, more or less tinged, and more on the hind than the fore wings, with dirty olivaceous green. *Fore wings* powdered throughout, but not uniformly nor always with the same intensity in the same regions, with white scales, giving the wing a grayish aspect; the markings of the upper surface are repeated beneath, slightly enlarged and, notably, the spots of the extra-mesial series are usually united in a continuous angulated band, often obscurely bordered with dark brown on the interior side; the nervules in the outer two-fifths of the wing are often traced in dull white and the outer border is often profusely sprinkled with white scales; the costal and outer margin and the fringe are as upon the upper surface. *Hind wings* crossed by three dull white bands: the inner is formed of three pretty large, independent, more or less quadrate spots, one in the middle of the basal half of the costo-subcostal interspace, a smaller one at the extreme base of the cell, its outer limits nearly touching the inner limits of the previous spot, and a similar one in the medio-submedian interspace below the first divarication of the median nervure; there is often also a small curving dash at the base of the costal nervure; the second band is a continuous, irregular, broad, but variable mesial stripe, running from the costal to the submedian nervure; in the costo-subcostal interspace it is obliquely lunate; in the subcostal interspaces it extends from the extreme base nearly half way to the outer margin; beyond the cell it forms a broad spot whose outer limit is like that of the neighboring part of the band above, and whose inner limit is straight and at the second divarication of the median nervure; in the upper median interspace it occupies only the extreme base, traverses the lower median interspace rather narrowly opposite the second divarication of the median nervure and without reaching the base of the interspace, continues in the same direction across the interspace below, broadening as it goes, terminating on the submedian with its inner limits at the middle of the nervure; the outer band consists of a regular, gently curving series of small, subequal, vague, roundish or arrow head spots in the middle of the interspaces, from the upper subcostal to the submedian nervules, lying midway between the middle band and the outer border, except in approaching the latter below the median nervules. The whole wing is covered rather sparsely with long white or greenish white hairs and scales, giving it a slightly hoary aspect, not so conspicuously, however, as on the fore wing; and in addition the costal and inner border and, frequently in a greater degree, parts or the whole of the outer border are rather profusely flecked with white, or on the outer border with pale greenish yellow; outer border occasionally edged with black. Fringe as on the upper surface.

Abdomen blackish brown, covered abundantly above with greenish gray hairs, beneath largely enlivened with paler hairs, and at the apices of the joints with similar pale scales; hairs of the terminal joint very pale, dull, greenish yellow. Upper organ of male appendages (35:45) with the hook arched, compressed, long and slender, tapering, pointed, sulcate above on basal half, separated from the centrum, which it equals in length, by a distinct constriction; lateral arms bearing beneath a compressed lamina, reaching scarcely beyond the base of the hook. Clasps about two and a half times longer than broad, narrowing pretty regularly, well rounded at the tip, the apical portion rising as high as the upper lobe from which it is separated, and which is marked only by a deep, narrow, slightly recurved excision, extending two-thirds way across the blade.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	13.5	14.3	15.	13.	15.	15.
antennae.....	6.5	6.75	7.1	6.05	6.55	6.55
hind tibiae and tarsi....	5.6	6.1	6.25		6.25	6.25
fore tibiae and tarsi....	4.25	4.5	4.95	3.85	5.	5.

Described from 1♂, 3♀.

Accessory sexual peculiarities. In the fold of the costal margin of the male fore wing occur some exceedingly delicate, elongated, lanceolate scales, tapering to the

finest possible point and terminating in a short flagellum (48:2c), the whole about .175 mm. long; besides these are similar slender and delicately lanceolate scales (2d, [between c and e]) but bluntly and roundly tipped; these both appear to have a granular structure; and so do other scales similar to the last but more peg-shaped, the apical half and sometimes nearly the whole being equal (2a) and truncate, or even broadly bifid at tip; but others which appear much like the last, but for being broader (2c, f) are clearly striate. Perhaps these last should in no case be considered androconia; the resemblance of the peg-shaped, pronged scales to some of those common in Pamphilidi, will be noted. The cover scales (2b) are mostly very large and broadly and irregularly oval.

This butterfly has a very extraordinary distribution (29:3). Until a comparatively recent time it was believed to belong to the scanty number of butterflies belonging to high northern latitudes, having been found only in eastern Labrador in this country and in Lapland and the mountains of central Scandinavia in Europe. But of late years it has been taken on the Canadian hills bordering the state of Vermont (Fyles), on Long Island (Calverly teste Edwards), Washington, D. C. (Edwards) and Coalburgh, W. Va. (Mead teste Edwards). French even credits it to North Carolina, but without further specification. Thus, although it has never been found in Europe south of the points mentioned, it has been taken in America far below its normal habitation, crossing even the whole width of two great faunas.

Wallengren says it flies in Scandinavia in June and July; in Labrador, according to Möschler, it is on the wing in July, when it is not abundant. Mr. Mead's specimens were captured in West Virginia in the latter part of April; it is then perhaps single brooded, flying late in the spring.

Desiderata. Collectors in the higher parts of New England should search for this butterfly in June, for it certainly must occur within its limits. The dates of capture should be noted and every fact recorded which can help form a history of the species, or acquaint us with its characteristics in the preparatory stages, of which we know nothing. As for its food plant, Mr. Fletcher tells me that there are no true Malvaceae in Labrador, its central home, and that probably the only Labiatae are *Mentha*, *Lycopus*, and *Scutellaria*. Probably it will be found on one of these.

LIST OF ILLUSTRATIONS.—HESPERIA CENTAUREAE.

- | | |
|-----------------------------------|--|
| Pl. 15, fig. 5. Both surfaces. | Pl. 48, fig. 2. Scales of male imago. |
| 35:46. Male abdominal appendages. | General. |
| | Pl. 29, fig. 3. Distribution in North America. |

TRIBE PAMPHILIDI.

Vigilantes + Juvenes Hübner.

Astycl (pars) Hübner; Astycl Scudder,
Mabille.

Pyrgidae (pars) + Thymelidae Burmeister.

Pamphilinae Butler.

What honey in the year's last flowers can hide
 These little yellow butterflies may know;
 With falling leaves they waver to and fro,
 Or on the swinging tops of asters ride.

ANON.

And when I wander here and there,
 I then do most go right.

SHAKESPEARE.—*Winter's Tale*.

Imago. Generally of small size, relatively slender. Antennae with a somewhat stout club, which usually tapers rapidly and has a slight hook or crook composed of from one to a dozen joints, much shorter than the mass of the club, occasionally absent and generally recurved at about a right angle. Costal margin of fore wings generally straighter than in Hesperidi, with no marginal fold, often furnished in the male with a complicated and conspicuous discal patch of varied scales and androconia; cell of same wings less than two-thirds as long as the wings; hind wings almost always entire, sometimes roundly lobed at the extremity of the submedian nervule. Abdomen as long as, or surpassing the hind wings, the extremity of the alimentary canal of the male not protected by any extruded sheath, but opening at the very base of the inferior part of the centrum; for the lateral arms originate from the very extremity of the inferior surface of the centrum or even beyond it, leaving an open space behind into which the anal orifice opens.

Egg. Very compact, almost hemispherical, the height much less than the diameter, the sides rounded and sloping off above, furnished with scarcely perceptible raised or indented lines dividing the whole surface into angular, pretty regular, minute cells; with rare exceptions without reticulation and then with very obscure vertical carinae, but with no connecting transverse lines.

Caterpillar at birth. Last abdominal segment with many very long bristly hairs, which are more or less strongly recurved.

Mature caterpillar. Head narrowing above, giving the whole head as viewed from in front a triangular or pyramidal aspect. Body very elongated, the abdominal segments usually divided by transverse creases into seven sections, adjoining pairs occasionally connate.

Chrysalis. Comparatively slender, nearly equal throughout its entire length, excepting the last two or three joints of the abdomen, the head scarcely, if at all, narrower than the thorax, always protuberant in the middle in front, sometimes mucronate; tongue case very long, extending free to some distance beyond the tips of the wing cases.

Characteristics of the tribe. The fore wings of the males of this most neglected but really very interesting tribe of butterflies are never furnished with a costal fold, but, instead, are often supplied with an oblique* dash of velvety appearance crossing the median nervules near the middle of the wing, and which is composed of extremely short and fine, most densely crowded, erect hairs and androconia. It is generally followed externally by patches of raised scales, often colored differently from the surrounding scales and is accompanied more intimately by loose, dark scales of

*In some Australian genera it is nearly transverse.

unusual size. This complicated structure is always found in all the species of the same genus but it does not always occur in neighboring genera, otherwise closely allied.

The prevailing colors of the butterflies of this tribe are tawny and black or brown, marked also, but often feebly, with pale, sometimes vitreous, spots, "the color being generally so disposed," remarks Westwood (Gen. diurn. lep., ii : 521), "as to leave a row of spots near the apical margin of the fore wings." He adds: "the colors in the female, moreover, are brighter than those of the male"; but the opposite is rather the case. The antennae are generally rather short and are provided with a short club, which usually attenuates rapidly and then bears a slender prolongation, recurved at about right angles; but there are a few genera in which the crook is wanting or very slight. There is very little variety in the form of the wings; the front wings are generally somewhat pointed and the hind pair are rounded, never tailed nor scalloped. Their flight is not so swift, nor generally so straight as in the Hesperidi, but still it is very rapid and strong and has more of the jerky, restless, uncertain motion which has gained the name of skippers for the group.

Habits of the butterfly. In repose, they hold their wings in the peculiar posture already alluded to,—the hind wings horizontal, the fore wings raised at a decided angle, their edges upon the plane of the former. Trimen remarks of the European *Augiades sylvanus* that it always rests with all the wings erect when alarmed at a passing object, in a shower of rain, or when resting for the night; and this I believe to be generally true of all the Pamphilidi, and they often take this attitude when they first alight upon a flower; it is mainly when sunning themselves that the characteristic heterotropic attitude is assumed.

They delight in the hottest sun and Harris is certainly mistaken in saying that they prefer "cool and shady places and most commonly appear on the wing toward the evening, which led Fabricius to give them a generic name indicative of this circumstance" (Ins. inj. Veg., 313). Such a statement refers throughout far better to the Hesperidi than the Pamphilidi. A large proportion of the species, in our northern states at least, are single brooded, and most of them hibernate either as mature caterpillars or in the chrysalis and fly in June; but in the south most, even of the species elsewhere single brooded, become digoneutic or polygoneutic. None, so far as is known, winter as butterflies, but some are known to hibernate in the egg, and others in all probability in the younger stages of the caterpillar.

Ulyett describes the method of oviposition of the European *Augiades sylvanus* as follows (Ent. monthl. mag., v : 129):—

She flew from one stem of grass to another several times, as if she were rather particular in her selection, and having found a suitable one, she slid gently down it. The movement was so easily yet so quickly done, that I could scarcely see whether it was

performed by means of the legs or the wings, but I rather think the former. When she was gone I opened the sheath formed by the leaf round the stem, and found therein about thirty small white eggs deposited in a line.

Habits of life in the early stages. The caterpillars feed almost exclusively upon Gramineae or allied endogenous plants and each forms for itself a vertical nest by connecting several blades of the plant it is eating by a loose, thin, open web of slender threads. I have never found any that would not feed on Gramineae, or refuse to lay eggs on that family of plants; but two of the European species, *Erynnis comma* and *Augiades sylvanus*, are said to feed on several genera of other families, the former on Leguminosae, the latter on Malvaceae, though Gramineae are also given as the food of the latter. There can be little doubt, however, that as a general rule the caterpillars of this tribe feed on endogenous plants, in contrast to the Hesperidi, which certainly prefer Leguminosae and are not known in a single instance, as far as I recall, to feed in nature on endogenous families; oviposition on these plants, however, is not essential, since the eggs of butterflies whose caterpillars feed on grasses are often laid indifferently on all sorts of other plants or on dead sticks, and I once found an egg of this tribe on a thistle, but the caterpillar died upon a thistle leaf without touching it.

On escaping from the egg the caterpillars nearly always devour the entire egg shell (excepting the base), before their feet touch any other than the shell surface. The caterpillars live almost entirely in concealment within the nests mentioned, rarely leaving them, but usually reaching out for their food from this cylinder and withdrawing at the slightest alarm; to aid them the caterpillars, in their earliest stage, but never so far as I have been able to see in any later one, are provided with long, recurved hairs on the last abdominal segment, by which a securer hold must be established within the very narrow nest. Moreover, they rarely feed at any other time than at night, so that a sight of one of these caterpillars, unless the nest is picked to pieces, is indeed a rarity; and this is the more striking when we consider that the butterflies of this tribe form a significant proportion of our butterfly fauna. In keeping with this is our almost total ignorance of any parasitic attack upon the members of this tribe. I believe that none whatever have been recorded previous to those mentioned beyond.

But there are one or two exceptions to this marked seclusion of life. No one who has raised many of the species will have failed to notice the bloom which appears on the back of some of the nearly grown caterpillars. Thwaites tells us (Moore, Lep. Ceylon, i:165), of the East Indian *Gangara thysis*, which feeds on Palmae, that "from the body a loose shaggy filamentous clothing, consisting of pure wax, is excreted, but which is easily rubbed off when handled, leaving the larva quite naked," and de Nicéville tells me, what is of special interest in this connection, that this caterpillar lives entirely exposed, stretching itself out upon the palm leaves.

The ragged filamentous appendages, which are doubtless secreted by the tubular bristles common to the Hesperidae through life, have, in the figure given by Moore, all the appearance of jagged spines and most probably secure for the caterpillar that protection which has induced an open habit of life. In diminutive keeping with this, the caterpillar of our own *Amblyscirtes vialis*, which of all our skippers known to me has the most palpable coating of extraneous matter, resembling the flocculent secretions of the Coccidae, and which is renewed early after each moult, also lives a partially open life, extending itself quietly at full length along the grass blades outside its nest for a considerable part of its later life. Exactly the same habit is found, according to Fletcher, in *Pamphila mandan*. This subject is one that should receive close attention.

In the change to chrysalis, the same nest that has served the mature larva or one entirely similar is made, only closed more tightly by a sieve-like silken mesh at all open places, and here the change takes place in a vertical position. In the few instances when I have seen it, I have been unable to make so careful an examination as is needed, but I have not been able to discover any transverse thoracic loop, nor, I believe, does any writer mention one. The attachment at the tail is likewise slight and apparently aided by a very feeble pad of silk specially spun for the purpose, which does not appear to take any definite shape. But I am not aware that any other observer has paid particular attention to this point, and my own opportunities have been too slight and unsatisfactory to be at all decisive.

Characteristics of the early stages. To the naked eye the eggs are invariably smooth, but in reality are furnished with excessively fine raised lines, dividing the surface into polygonal cells; very rarely these are absent, and in their place appears a faint, sometimes nearly imperceptible, vertical ribbing. They are hemispherical in shape and differ markedly from the higher tribe in the almost invariable absence of vertical ribs, and total want of cross lines.

The caterpillars at birth have a plump, fat, cylindrical body, with a massive globose head of disproportionate size and a body provided with rows of short, tubular, apically expanding bristles, besides some very long, recurved pointed bristles on the last segment. The mature caterpillars have a pyramidal head, not very large in proportion to the body except for the strangled neck, a long and slender body tapering at each end and studded profusely with minute papillae supporting pile. They are sometimes longitudinally, very rarely transversely striped, but usually nearly uniform.

The chrysalids are slender and elongated, the front often with a projecting slender point or horn, the tongue case extending free, sometimes to a great distance, beyond the tip of the wings.

One species, closely allied to an American group, has been found fossil in the tertiaries of Aix, France.

Table of the genera of Pempiliidae, based on the imago.

Club of antennae not drawn out at the tip nor recurved.

Terminal joint of palpi lightly clothed and free from the clothing of the second joint, exceptionally slender and long, porrect; fore tibial epiphysis present; hind tibiae with two pairs of spurs.....**Ancylolophia**.

Terminal joint of palpi heavily clothed and much obscured by the clothing of the second joint, pretty long but not exceptionally slender, advanced; fore tibial epiphysis absent; hind tibiae with only one pair of spurs.....**Pamphila**.

Club of antennae with a distinct, though sometimes slight, recurved apical crook.

Third joint of palpi long and slender; apex of fore wings bluntly angled, not produced; cell of fore wings only three-fifths the length of the wing; fore wing of male usually provided with a stigma; upper half of hind wings longer than lower half.

Crook of antennal club short and rapidly tapering, scarcely longer than the width of the moderately stout club; costal margin of fore wings scarcely concave in apical half.....**Amblyscirtes**.

Crook of antennal club long and gradually tapering, fully twice as long as the width of the slender club; costal margin of fore wings scarcely convex in apical half.

Second joint of palpi short oval, not more than half as long again as broad; club of antennae, apart from the crook, decidedly arcuate.....**Poanes**.

Second joint of palpi long oval, fully twice as long as broad; club of antennae, apart from the crook, straight.....**Phycanassa**.

Third joint of palpi generally short; apex of fore wing more or less pointed; cell of fore wing (excl. *Lerema*) more, often much more, than three-fifths the length of the wing; no stigma on fore wing of male; lower half of hind wings as long as, or longer than, the upper half.

Hind tarsi shorter than, though sometimes nearly equal in length to, the middle tarsi.

Prevailing colors of the upper surface of the wings tawny

Hook of antennal club as long as the width of the club with no discal stigma on the fore wing.....**Atrytone**.

Hook of antennal club shorter than, generally much shorter than, the width of the club; male with a discal stigma on the fore wings.

Antennae hardly longer than the width of the thorax.....**Hylephila**.

Antennae twice as long as the width of the thorax.

Cell of fore wings two-thirds as long as the wing.

Club of antennae only moderately stout; fore tarsi nearly five-sixths as long as the middle tarsi; stigma of male fore wing followed beneath by a conspicuous field of elevated scales.....**Atalopedes**.

Club of antennae very stout and plump; fore tarsi only two-thirds as long as the middle tarsi; stigma of male fore wing with no conspicuous inferior field.....**Erynnis**.

Cell of fore wings only about three-fifths as long as the wing.

Larger forms. Basal joint of palpi greatly expanded apically; middle and hind tibiae conspicuously spined on the upper surface, as elsewhere; outer margin of hind wings scarcely lobed at submedian nervure.....**Anthomastor**.

Smaller forms. Basal joint of palpi not apically expanded; middle and hind tibiae with no conspicuous spines on upper surface; outer margin of hind wings with no sign of a lobe.....**Polites**.

Hind tarsi (excl. *Lerema aclus*) longer than the middle tarsi. Prevailing colors of the wings brown.

Antennal crook moderately stout, hardly longer than the width of the rather short and stout club; last joint of palpi slender.

Cell of fore wing only three-fifths the length of the wing; discal stigma of fore wing of male discontinuous, and followed beneath more or less conspicuously by a substigmatic area of special scales.....**Thymelicus**.

Cell of fore wing nearly two-thirds as long as the wing; discal stigma of fore wing of male continuous, and followed beneath by no substigmatic area of special scales.....**Limochorea**.

Antennal crook slender and finely drawn out, much longer than, sometimes twice as long as, the breadth of the long and relatively slender club; last joint of palpi generally relatively stout.

Basal joint of palpi not expanded apically; antennal hook not exceptionally long; males with a discal stigma on fore wings above.

Cell of fore wings about two-thirds as long as the wing; second joint of palpi long oval, very slender; markings of the under surface of the hind wings in the form of slender rows of spots.....*Euphyes*.

Cell of fore wings about three-fifths as long as the wing; second joint of palpi short oval, very stout; markings on the under surface of the hind wings in the form of broad, clouded areas.....*Lerema*.

Basal joint of palpi greatly expanded apically; antennal hook exceptionally long and attenuated; males with no discal stigma on fore wings above.

Exceptionally large forms. Fore wing less than twice as long as broad; its outer margin more than usually transverse, much shorter than inner margin; cell of same very narrow, fully two-thirds the length of the wing; hind wings distinctly lobed at the submedian nervure.....*Calpodex*.

Forms of normal size. Fore wing much more than twice as long as broad; its outer margin very oblique, as long as the inner margin; cell of same moderately broad, less than two-thirds as long as the wing; hind wings with no lobe.....*Oligoria*.

SECTION 1.

Egg usually low, the height usually less than two-thirds the breadth, occasionally feebly ribbed vertically. *Caterpillar at birth* with relatively short bristles on the terminal abdominal segments, usually not more than one-third as long as the breadth of the head. *Mature caterpillar* with a pyramidal head, very much higher than broad, thrown backward, the face upward when at rest. *Chrysalis*, so far as known, with a bluntly rounded front. *Imago* with the antennal club usually without any distinct hook, and then the abdomen exceptionally long and slender, and sometimes the fore tibial epiphysis and middle pair of spurs of hind tibiae wanting; no discal stigma on the fore wings of the male; lateral arms of upper organ of male abdominal appendages soldered to the parts above it throughout its whole or very nearly its whole extent.

GENERA: *Ancyloxipha*, *Pamphila*, *Amblyscirtes*.

ANCYLOXIPHA FELDER.

Ancyloxipha Feld., Verh. zool.-bot. gesellsch. Heteropterus pars Auctorum.
Wien., xii: 477 (1862). Thymelicus pars Auctorum.

Type.—*Hesperia numitor* Fabr.

The butterfly is glancing bright
Across the sunbeam's track.

HEMANS.

Deus est magnus in magnis,
Maximus autem in minimis.

ST. AUGUSTINE.

Imago (58:5). Head excessively large, clothed with short scales and transverse rows of long hairs; outside the base of the antennae, a rather conspicuous lateral curving bunch of nearly equal bristly hairs, spreading in a vertical plane and reaching about half way around the circumference of the eye. Front a little tumid, surpassing a little and almost equally the front of the eyes, rather more than twice as broad as long, separated from the vertex by a scarcely perceptible, straight, transverse ridge, connecting the middle of the antennal bases; the whole front margin and sides rather coarsely emarginate, the middle half of the front straight, sloping off laterally toward the sides, which are straight on the hinder half, rounded off in front and reach the outer extremity of the antennae; vertex scarcely

tumid, a very little fullest in the middle of each half, elevated a little and especially in front above the level of the eyes, forming almost the entire summit, in contradistinction from the front which forms nearly the whole face (in which point it differs from nearly or quite all genera of Hesperidae), nearly half as long again as the front and separated from the ocellus by two slightly, nearly continuous, curved lines; the front lateral angles are cut diagonally behind the antennae. Antennae inserted at the front margin of the summit, their inner edges separated by a space equal to the diameter of the eye, or nearly four times that of the antennal bases, the whole antenna about two-thirds the length of the abdomen, composed of twenty-five joints, of which thirteen form the club; this is more than one-third of the whole antenna, cylindrical, a little appressed, increases regularly in size up to the eighteenth joint, where it is as broad as the combined length of the seventeenth and eighteenth, and beyond which the joints decrease, both in size and length, rapidly diminishing to a pointed apex, the final joint being slightly produced and bent at an angle with the others, not more than one-third the diameter of the stalk; the tapering portion, although made up of fully half the joints of the club, is scarcely one-third the length of the basal portion and the change of size is mostly on the upper surface, the lower being nearly straight; the joints in the middle of the stalk are about three times as long as broad. Palpi rather stout below, heavily covered with loose scales, beyond which the terminal joint, covered only with recumbent scales, protrudes wholly and conspicuously, the whole about two and one-half times longer than the eye; basal joint very small, cup-shaped, the anterior part of the apex slightly and tumidly produced, about one-fourth the length of the middle joint; the latter large, tumid, straight, subovate, the base broadly rounded, the apical half subconical but rounded, the apex produced into a slight neck upon which the terminal joint is seated, scarcely inclined forward; it is scarcely three times longer than broad; terminal joint exceedingly long and slender, tapering very gently, mostly in its apical half, straight, *very nearly as long as the middle joint*, but no broader than the apical half of the tongue.

Prothoracic lobes very strongly appressed, laminate; when viewed from the front, the inner and inferior margins straight and at right angles to each other, the upper outer margin strongly arcuate, about two-thirds the length of the diameter of the eye. Patagia closely resembling those of Hesperia.

Fore-wing (42:3) less than twice as long as broad, the lower outer angle falling a little within the apical third of the costal margin; costal margin a little and pretty regularly convex throughout; outer margin gently convex; apex well rounded. Costal vein reaching the middle of the costal border; subcostal nervure distant from the margin of the wing, its first nervule originating scarcely beyond the basal third of the wing; cell less than three-fifths the length of the wing; first branch of the median arising opposite a point midway between the base of the first and second subcostal nervules; internal nervure inconspicuous, very short, not turned upward at the tip.

Hind wing very elongated, half as long again as broad, strongly and regularly rounded apically in the lower part of the subcostal region, elongated at the anal angle; the branches of the median vein closely approximate at their bases.

Legs 2, 3, 1; all the femora fringed beneath with moderately abundant and not very long, nearly equal hairs. Femora 2, 1, 3; tibiae 2, 3, 1; tarsi 3, 2, 1. Fore femora but little longer than the hind pair, three-fourths the length of the middle pair; fore tibiae two-thirds the length of the fore femora, three-fifths that of the other tibiae. Leaf-like appendage of the fore tibiae very slender, attached at the middle of the outer four-fifths of the joint, surpassing a little its extremity, nearly straight, pointed at the tip and four or five times as long as broad; other tibiae armed at tip with a pair of long spurs, a little stouter in the ♂ than in the ♀, the hind tibiae with an exactly similar pair just before the middle of the outer two-thirds. Tarsal joints 1, 2, 3, 4, 5, excepting on the fore legs, where they are 1, 2, 3, 5, 4, the apical distinctly longer than the penultimate joint; fore tarsi of the length of the middle femora, a little less than two-thirds as long as the hind tarsi, a little more than two-thirds as long as the middle tarsi, —all with a triple row of minute, delicate spines, the

apical ones of each joint a little longer than the others; basal joint almost equalling the length of the second, third and fourth together, the second about half as long as the basal joint. Claws small, delicate, pretty strongly and regularly curved. Pad pretty large, nearly circular; paronychial exceedingly slender, thread-like, about one-third as long as the claws.

Upper organ of male abdominal appendages small and slender; centrum depressed, above scarcely longer than broad; hooks consisting of a depressed, arcuate, scarcely tapering ribbon, overlaid by a median, slender hook and bearing beneath a compressed lamina with an anterior tooth. Clasps exceedingly long and slender, and, until divided, nearly equal; upper lobe very long and slender, parallel to the apical lobe which is equal and extends backward and curves upward.

Egg. Low, scarcely forming half a sphere, uniformly rounded, the base very broadly truncate, its rim rounded, the height exceeding by very little half the diameter; surface covered with inconspicuous, polygonal, somewhat lozenge-shaped cells; micropyle rosette consisting of a pretty large cluster of irregularly disposed, angular, usually hexagonal cells of a nearly uniform size.

Caterpillar at birth. Head tumid, the sutures a little impressed. Body rather short and plump, nearly equal, tapering at either extremity; dorsal thoracic shield narrow and transverse, with a separated triangular piece just above the spiracle; the segments of the body divided into three sections by two transverse creases; minute papillae arranged as follows: a subdorsal anterior row, a lateral posterior row, a suprastigmatal posterior row, and an infrastigmatal central row; dermal appendages supported by these papillae long, straight, tapering, not perceptibly enlarged at tip, though presumably truncate; those of the subdorsal series are directed inward, of the lateral a little forward, upward and inward, of the suprastigmatal series forward, of the infrastigmatal erect; besides there are long, recurved, tapering bristles on the terminal segment, as described under the species.

Mature caterpillar. This was observed in life only in the second stage and insufficient notes taken. The dorsal thoracic shield narrows on the sides without reaching the spiracle; the body is covered with regularly distributed papillae, each bearing a short, tapering, delicate hair; otherwise much as in the caterpillar at birth.

Chrysalis. Rather long, nearly cylindrical, obtusely rounded at the anterior extremity, tapering behind; tongue reaching the base of the cremaster; free terminal joints of abdomen forming a rapidly tapering, conical mass, the cremaster exactly continuing the lines of the cone, bluntly rounded at tip, and a little compressed, so as to be twice as broad as thick, the apical field of hooklets small and almost linear; these segments are furnished with linear series of minute tubercles, each bearing a strongly depressed, backward directed, short, curving, pointed bristle; there is in particular an infralateral series at least two to a segment, a suprastigmatal series and an infrastigmatal band, three or four to a segment, besides many ventrostigmatal ones; anal hooklets short, enlarging almost from the base, strongly crooked and expanded. Described from the terminal portion of a specimen and the figures and notes of Harris.

This genus, peculiar to America,* seems to spread over a district which very commonly forms the boundary of Hesperidan genera, viz., that part of America east of the Rocky mountains and including the Antilles, which lies between Lat. 15° and Lat. 45° N. But three species are known, one belonging to the southern portion of the main land, one to the Antilles and one to the United States†. The latter is common in the southern half of New England.

The butterflies resemble but little other Hesperidae. Their simply

*Some of the species, placed in this genus by Felder, do not belong here.

†A fourth, listed by the late Horrich-Schaefer

under the specific name *Iopora*, but, I believe, not yet described, occurs in Venezuela.

clubbed antennae, long, porrect palpi, with the greatly produced apical joint, their feeble wings and their excessively slender body, all form characters which are in marked contrast to the uniformity of the other members of the family in these particulars. They are among the very smallest of Hesperians—and indeed of butterflies, their wings broad, entire, and dark brown, varied above with fulvous discal areas of greater or less extent, the under surface of the hind wings almost wholly fulvous.

The transformation of none of the species are perfectly known but the northern species is triple brooded, probably hibernating as a chrysalis.

The butterflies differ from all other members of the family to which they belong, in the feebleness of their flight and their general lack of vigor; their flight is even weaker than that of the Satyrids and recalls them in its dancing movement, not strictly in accordance with that of the Hesperidae. They are fond of moist and hot situations, living beside streams through sunny meadows. The larvae feed on Gramineae, constructing, from the beginning of their life, little nests wherein to live.

The eggs are nearly hemispherical, flatter than those of any other of our Hesperidae and thus readily distinguished. The juvenile larvae are unusually short and the dermal bristles have no apparent enlargement at tip. The full grown caterpillars are not known, but one species in the second stage is uniform pale yellow, with a brown head all covered with pile. The chrysalis of the same, according to Harris, is slender with a bluntly rounded head and conical, rapidly tapering abdomen with large cremaster.

EXCURSUS LX.—A BUDGET OF CURIOUS FACTS ABOUT
CHRYSLIDS.

What are called butterflies, however, are generated from caterpillars; but caterpillars are generated from green leaves, and especially from *raphanos*, which some call cabbage, and at first, indeed, something less than a grain of millet is produced; afterwards small worms originate from this; and these increasing, in the space of three days are formed into small caterpillars. Such caterpillars, also, when increased, cease from motion, change their form, and are called *chrysalides*, or *ovules*. . . In a short time . . . the shell bursts, and winged animals fly out of it, which we call butterflies.

ARISTOTLE.—*History of Animals* (Taylor's transl.).

EXAMINE any butterfly chrysalis you please and you will find on either side of the head, close to the base of the antennae and partially overlapped by them, a smooth crescent-shaped belt, which generally contrasts rather strongly with the roughened surfaces about it. It corresponds closely in position with the curving row of simple ocelli found on the head of the caterpillar, where it is generally marked by a distinct impression; it also lies across the middle of the convexity which marks the position of the compound eye of the inclosed butterfly; the convex case of the rest of the

eye is rough and coarse like the chrysalis skin generally, but this curved ribbon is smooth and thin, and regularly embossed, each gentle elevation apparently corresponding to the centre of a facet of a compound eye (86:22). Now it has been suggested that this belt is a window through which the prisoner may look abroad; what end this would serve is not explained; nor have the structure, form, and position of the belt been taken into consideration. No underlying structure, as far as I am aware, has been found related to it alone; and as an external covering of an eye its structure is midway between that of the caterpillar and the perfect insect. May it be a relic of the past, the external sign of what once was? Are we to look upon this as one hint that the archaic butterfly in its transformations passed through an *active* pupal stage, like the lowest insects of to-day, when its limbs were unsheathed, its appetite unabated, and its daily necessities required the use of a compound eye, such as would result from the multiplication and conglomeration of simple eyes within the normal ocellar field of the larva? This, it is true, is merely speculation; but whatever explanation of the structure of this glassy band is given must account for its form and its relation to the larval row of tubercles.

There is another peculiarity in the head of certain chrysalids which demands our attention and an explanation of its cause, since it is found in some groups and not in others. On either side of the front of the head there is often a roughened angulate or conical projection, bearing no relation whatever to the parts beneath, but looking like a pair of clumsy horns or ears projecting forward; other chrysalids have the front extremity prolonged in the middle, while the sides of the head are quite smooth and regular; others again have the same smooth and bluntly rounded head which generally characterizes the pupa of moths. Since these projections are mere extensions of the pellicle and quite hollow, it might be presumed that they indicated some variation in the life of the chrysalis; and such at least generally is indeed the fact. Many chrysalids are protected by some sort of a cocoon; and these have perfectly smooth and rounded heads; so, too, have those which, though exposed, are girt immovably to the object they have chosen as their support. Other chrysalids are attached by the tail and loosely bound about the middle by a girth which allows the body to sway from side to side; while still others hang freely by their hinder extremity. In these two latter cases the chrysalids may be blown hither and thither by every breeze and are liable to injury from neighboring objects; as in all cases the tail is fastened, their point of greatest motion is of course the head, and this, therefore, is guarded by projecting roughnesses. In those which hang freely there are some exceptions to this rule, as in the case especially with the Satyrids, but even here some angulations or little conical tubercles may be discovered; and, besides, the chrysalis stage of such species is invariably passed in midsum-

mer, and therefore is very brief. So far as I am aware, every chrysalis which lives through the winter, and whose body hangs at the mercy of the wind, has its head protected as I have described; those which hang freely have always the two frontal projections; those which are also loosely girt about the middle sometimes have the same, or they may have the single extension in front. It is indeed, only by exception that any of our pendant chrysalids pass the winter at all. So good an observer as Rambur, whose observations were made in Spain long ago, remarked: "*Je ne connais, du reste, aucune espèce dont la chrysalide soit suspendue, qui passe l'hiver en cet état.*"

It may also be noticed that chrysalids with extraordinary projections or ridges in other parts of the body all belong to the same free-moving groups; the greater the danger to the chrysalis from surrounding objects, the greater its protection by horny tubercles and roughened callous ridges; the greater the protection possessed in other ways, as by firm swathing or a safe retreat, the smoother the surface of the body and the more regular and rounded its contours. We have thus a complete explanation of all the angularities in the surface of the body, with the sole exception of certain horn-like protuberances on the front of the head in some *Pamphilidi*, which may possibly be of use in keeping the body from too great movement in the cocoon-like enclosure in which the chrysalis is protected.

There is another peculiarity in our chrysalids which strikes one as odd when first noted, though it is not confined to them alone. In certain instances the chrysalids of neighboring groups very nearly resemble each other when the caterpillars from which they came differ strikingly; and the reverse is equally true. No better instances can be given than in our genera of swallowtails: The chrysalids of *Jasoniades* and *Papilio*, for instance, are very much alike, and would often be mistaken for each other did the size agree; while the caterpillars from which they came differ in the most striking manner, not only in color and markings — a difference of special importance in naked caterpillars — but also in form. To reverse the picture, the caterpillars of *Jasoniades* and *Euphroeades* are of precisely the same form and color, on a first view differing only in some minor points of markings, while their chrysalids seem made on quite a different plan.

One finds the same thing true in certain groups if the other stages of life are also examined. It only serves to show that selection has seized upon every available point of structure at each stage of life, and quite independently; so that it is only by the summation of characteristics of all the stages that we may arrive at a true conception of their actual relationships. In some groups selection has apparently found nothing in one stage to seize upon to answer its ends, and all the members of that group show then a dull uniformity which would seem to indicate no great antiquity, or in other words a very intimate relationship between its different members; when,

if another stage be studied, we find at once where selection has been employing her forces and can only regard the differences here as marks of an immense lapse of time since the common ancestor of all flourished upon the earth.

But to leave these general considerations and to return to our chrysalids. We have pointed out some common features of interest about their structure. Can we find anything worthy of remark in the life of such apparently lifeless things? Certainly; we may fairly call a chrysalis a most fickle object; a most uncertain creature. Has it not been mentioned over and over again in this work that while one brood may follow another with tolerable regularity, broods are very apt to be uneven in their numbers, because some chrysalids fail to disclose their inmates at the expected time but wait a little or a longer time? That there should be some little variation due perhaps to conditions of temperature were to be expected; but that the continuance of the chrysalis should be just enough to have it skip a brood is certainly reason for wonder, for here meteoric conditions can often have clearly nothing to do with it. Some instances, indeed, are on record where, when normally a single winter would mark the duration of a chrysalis, it has lasted two winters and, of course, the intervening summer. All these variations seem to be provisions of nature to guard against destruction of the species under adverse circumstances. Nature seems always on her guard.

Or take a kindred fact. It is well known to the aurelian that the males of a given brood almost invariably make their appearance before the females, sometimes only a day or two, sometimes as many weeks. It seems only another instance, so many of which are known in both animal and vegetable kingdoms, of a device to secure fertilization. Now, Mr. Edwards, with his unrivalled experience in breeding butterflies, tells us, what all of us have seen on a smaller scale, that when bred in confinement, not exposed to all the vicissitudes of the weather, the females appear quite as early as the males. What subtle influence then is it which earlier awakes the male under wholly natural conditions?

We owe to Wilhelm Müller (a brother of Fritz Müller, who has made so many neat observations in the natural history of tropical animals) a curious fact in the lives of the free hanging chrysalids of tropical Nymphalidae. Every naturalist knows how rarely these chrysalids are discovered in free nature; most of our knowledge of them comes from those raised in confinement; for the caterpillar nearly always seeks an obscure place in which to change or else imitates in its color and perchance in its form, surrounding objects. Now Müller has discovered that many of them are directly sensitive to light and will respond, slowly indeed but effectually, to its presence. To experiment upon them he devised an arrangement by which the light—not the direct rays of the sun, but merely

its light—could be thrown upon them from one direction or another without touching them, and he found them capable of changing their position, some of them from side to side, some from a pendant to a horizontal position, through an angle, varying in the species, of from 45° to 70°, or even 90°, in order to present as little surface to the light as possible, to get, as it were, in the shade; some responded to changes as frequent as a dozen in six hours. The experiments were made with a number of species; one of them was an *Ageronia*, which, pendant when in the dark, in the light hugged the horizontal surface from which it hung so as to assume the attitude of a girt *Papilionid*, whence arose, Müller believes, the error of Lacordaire and others, who asserted *Ageronia* had a girt chrysalis. As not a few of the chrysalids most frequently experimented on died or produced crippled butterflies, Müller believes that too much light is injurious to them and reasoned that this movement was therefore one of protection. But he found one very strange exception to the rest in a species of *Catonephele*, which responded to his experiments in an exactly opposite manner, bending to receive on its side the fullest amount of light and reversing its position when the light was transferred to the opposite quarter. Surely we have much yet to learn from apparently lifeless chrysalids.

ANCYLOXIPHA NUMITOR.—The least skipper.

[Least yellow skipper (Abbot); bordered skipper (Harris); wee skipper (Scudder).]

Hesperia numitor Fabr., Entom. syst., iii: 324 (1793);—God., Encycl. méth., ix: 725, 776-777 (1819);—Westw., Don. Ins. Ind., 67, pl. 44, fig. 3 (1842).

Papilio numitor Abb., Draw. Ins. Geogr. Br. Mus., vi: 96, figs. 144-146;—Herbst., Natursyst. Ins. schmett., xi: 390 (1804).

Erycina numitor God., Encycl. méth., ix: 561, 587 (1819).

Pamphila numitor Westw.-Hewitts., Gen. diurn. Lep., ii: 523 (1852);—Morr., Syn. Lep. N. Amer., 120 (1862).

Cyclopides numitor Butl., Catal. Fabr. Lep., 279, syn. excl. (1869).

Thymelicus numitor Butl., Entom. monthl. mag., vii: 94 (1870).

Ancyloxipha numitor Feld., Verh. zool.-bot. gesellsch. Wien., xii: 477 (1862);—Scudder., Syst. rev. Am. butt., 53 (1872);—Fern., Butt. Me., 96 (1884);—French, Butt. east. U. S., 301 (1886);—Mayn., Butt. N. Engl., 66-67, pl. 5, figs. 84, 84a (1886).

Thymelicus puer Hübn., Verz. schmett., 113 (1816);—Zutr. exot. schmett., ii: 17, figs. 275-276 (1823).

Heteropterus marginatus Harr., Ins. Inj. veg., 3d ed., 308, figs. 131, 136 (1862).

Figured also by Glover, Ill. N. A. Lep., pl. 30, fig. 8; pl. 31, fig. 6, ined.

The innocent looks up with eyes
That know no deeper shade
Than falls from wings of butterflies,
Too fair to make afraid.

KATHERINE BATES.—*A Song of Waking.*

Imago: (10: 7; 13: 13). Head covered above with blackish scales, mostly concealed by lemon yellow hairs, inclining to tawny, and with a few intermingled dark brownish ones; beneath white, with a narrow belt of the same encircling the eye, excepting in front, and broken only by the pencil of black hairs on the outer side of the

antennae and again at a point a little behind it. Palpi white at base and on the basal half of the middle joint, especially on the sides; below and above it changes to tawny on approaching the tip, mingled above and at the tip with many blackish scales; along the lower edge of the outer surface a row of distant, long, delicate, black bristles, besides which there are many scattered, elongate, black scales dotting the under surface, increasing in number toward the tip; apical joint blackish brown, enlivened on the sides with tawny. Antennae blackish brown, narrowly annulated with white at the base of the joints, broadest posteriorly, where, at the base of the club, those of consecutive joints merge into a continuous silvery white band. Naked portion of the tip brighter or duller luteous. Tongue blackish castaneous, luteo-castaneous at tip.

Thorax covered above with dull, tawny hairs, becoming brownish tawny on the patagia; beneath with dull white scales and hairs. Legs blackish brown, overlaid with pearly white scales and hairs on the outer and under surface, and on the femora also on the inner surface; on the tarsi the white is tinged with buff and encircles the basal half of the joints; the inner side of the tibiae is also besprinkled with white scales, and the leaf-like appendage of the fore pair is dull luteous; spurs white, brown beneath and at tip; spines pale buff; claws luteous.

Wings above tawny, broadly bordered with dark brown. *Fore wings* generally so extensively suffused with the same as to be better described as dark brown, flushed with dull tawny, especially above the cell, but excepting the costal edge and the extremities of the subcostal nervules; the discoidal cell, and particularly its apical half, is usually darker than the surrounding parts. Fringe obscure dark brown, apically a little paler, or mingled pale and brown. *Hind wings* with the disc bright tawny, a uniform broad border extending along the whole costal margin as far as the subcostal nervure and around the outer margin, as far as the lowest median nervule, beyond which it narrows more or less, and terminates at the submedian nervure; in addition, the basal three-fourths of the inner margin is narrowly bordered with griseous and similar clusters of scales obscure the basal fourth of the wing between the nervures; the basal half of the wing is covered with frequent long, tawny hairs. Fringe tawny, mingled with a very few brownish scales, and apically with paler ones.

Beneath golden tawny, the hind wings immaculate, the fore wings slightly darker than the hind wings, and not only, as often on the hind wings, edged throughout with a dark brown line thickened a little at the nervure tips on the costal margin, but with the whole lower portion of the wing uniformly fuliginous brown, bounded above by the subcostal nervure, and limited outward by a line drawn from the tip of the third superior subcostal nervule to the inner angle of the wing. Fringe of fore wings dusky brown, suffused, especially in the middle, with saffron; fringe of hind wings of the ground color of the wings.

Abdomen very dark purplish brown above, on the sides tawny, beneath white. Upper organ of male appendages (37:1) with the hook-ribbon tapering but little, apex squarely docked or a little concave; it is twice as long as the breadth of the tip, which is directed downward; the overlying hook is like a curved needle; the inferior lamina is nearly as deep as the centrum, and its anterior tooth depends as far as the hook. Clasps fully six times as long as broad, the basal two-thirds undivided, nearly equal, with a slight elevation near the middle above; upper lobe exceedingly slender, equal, bluntly terminated, two-thirds as long as the apical portion of the blade, and having the same direction as it; the latter is half as broad as the basal portion of the clasp, equal, bluntly terminated, curved considerably upward and turned inward a little, the apex furnished with minute prickles.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 8.75 mm.						
Length of fore wing.....	10.	11.	12.15	11.75	12.	13.
antennae.....	4.	4.5	4.85	4.25	4.65	4.85
hind tibiae and tarsl..	4.5	5.	6.	5.3	5.9	6.45
fore tibiae and tarsl..	3.	3.	3.5	2.75	3.	3.55

Described from 58 specimens, of which 36 ♂, 12 ♀.

Egg (66:22, 25). Surface smooth, glistening, broken up by shallow, narrow, indented lines into polygonal, generally somewhat lozenge-shaped cells, from .017 mm. to .021 mm. in diameter, and dotted profusely with minute punctuations; micropyle rosette (69:8) .1 mm. in diameter, the cells varying from .013 mm. to .021 mm. in size. Color when first laid bright shining yellow; in two days streaks and irregular ragged patches of deep orange-red, connected in a band around the egg, half way up, indicate the changes occurring within. Height, .39 mm.; breadth, .7 mm.

Caterpillar. *First stage* (73:4). Head (80:51) black, shining; surface very minutely shagreened with a few delicate, whitish hairs, .04 mm. long; antennae fuscous; ocelli black; mouth parts apparently black. Body pale yellow, tinged anteriorly and posteriorly with pale reddish brown; dorsal thoracic shield black; dermal appendages long, straight, tapering, blackish fuscous, .04 mm. long, seated on minute papillae, those of the subdorsal rows .08 mm. apart on the same segment; at the anterior base of those of the second and third thoracic segments is a small, colorless papilla; on the terminal segment there are two subdorsal, recumbent, recurved bristles, .1 mm. long, directed also inward so as to cross; just anterior to these is another similar but shorter pair; and around the hinder margin of the anal plate four straight bristles, directed backward, with a similar one on each side of the hinder end of the penultimate segment; they are from .065 mm. to .085 mm. long, the outer ones of the anal plate being the longest; spiracles concolorous; legs yellowish, somewhat infuscated; prolegs yellowish. Length, 1.3 mm.; breadth of body .24 mm.; of head, .35 mm.; dorsal thoracic shield not more than .03 mm. in length.

Second stage. Head dark castaneous brown, nearly black, with a few very short and very delicate, scattered pale hairs; triangle paler; ocelli dusky pellucid surrounded by a black field. Body pale greenish yellow; dorsal thoracic shield brownish fuscous; minute blackish fuscous papillae regularly scattered all over the body, each giving rise to a short, delicate hair, .04 mm. long; legs and prolegs pale yellowish. Breadth of head, .52 mm.

Chrysalis. Reddish ashy color, minutely sprinkled with brown dots (Harris); the terminal segments of the abdomen (all that remain of the Harris specimen) are dark luteo-testaceous, the tubercles blackish fuscous, the bristles of the same color; the sides of the cremaster, as of the preanal button, especially the latter, deeply channeled, the whole inferior surface of the cremaster longitudinally combed; the surface of the abdominal segments with weak and fine transverse ridges.

Distribution (29:4). This butterfly apparently occurs throughout the whole extent of the Carolinian and Alleghanian faunas; in the former it extends from eastern Florida (Brit. Mus.) northward through Georgia "not very common" (Abbot) and South Carolina, abundant on the sea coast (Scudder), and westward to Texas, Dallas (Boll), Collette River, moderately common (Aaron), although at Demopolis, Ala., Mr. Grote has "seen but one specimen." Mabille even gives it from Brazil! In the Alleghanian fauna it has been frequently found in the west and as far as eastern Kansas, not common (Snow), Ames, Iowa (Osborn) and Wisconsin, numerous (Hoy), and its northern limit is indicated by the following stations: St. Catherines, Ontario (Saunders), Canada West (Brit. Mus.), Rockport, Ohio (Kirtland) and southern Michigan "common" (Harrington). In New York it has been found about Albany and Bethlehem, in the former place abundantly (Lintner), and in the Province of Quebec at Shefford (Fyles).

In New England it is abundant south of the northern boundary of Mass-

achusetts, but has been recorded from only two localities north of it, Norway, Me. (Smith) and Milford, N. H. "common" (Whitney). It will probably be found somewhat further north.

Haunts. The butterfly frequents low marshy meadows and the borders of runlets passing through them, especially where haunts choked with wild grasses, or in neglected bottom lands in the moister spots, but especially next to running water. Abbot gives, as for most of the skippers, "oak woods," but it would probably be in somewhat similar stations therein that he found them, particularly as he adds: "fields in low grounds." In another manuscript he says the least yellow skipper "is frequent in rice fields and meadowy parts of branches" (i. e. small streams) which is precisely as elsewhere.

Oviposition. All of the eggs I have seen were laid in confinement, many of them received from Messrs. Hambly and Clapp who simply enclosed females in pill boxes; in these instances they were generally deposited on the sides of the boxes, but occasionally on the bottom; others were laid on the sides of erect blades of grass. They hatch in June and July in nine or ten days; in September in from five to seven days.

Food and habits of caterpillar. The caterpillar feeds readily upon common grasses. Probably its natural food will be found to be some of the wild grasses which love much moisture. When first hatched it constructs a nest for itself on either side of a blade of grass by fastening together the opposite edges with from five to twelve strong bands of silk, the threads of each band crossing one another, thus making the bands broader at their origin than in the middle; after their first moult, this is perfected by closing the interstices with a thin irregular web of silk; behind or beneath this the caterpillar remains. Specimens which hatched in an empty box surrounded themselves with a broad carpet of silk on all sides excepting behind, leaving also the spot on which they rested uncovered.

Life history. It is triple brooded and passes the winter either in the chrysalis or as a mature larva. It appears on the wing early in June, occasionally as early as the 1st but ordinarily not before the 7th in the southernmost parts of New England or the 10th or 12th in the vicinity of Boston; occasionally it is a little later; by the middle of the month it is not only abundant but by this time, if not earlier, the females, which are always later than the males, have begun to lay eggs; by the 21st the numbers begin to diminish and it seldom continues into the following month. The eggs hatch in nine or ten days and the young larva, moulting for the first time in four days, probably attains its growth by the middle of July; the duration of the chrysalis stage is unknown, but the second brood of butterflies makes its advent during the last week of July, generally between the 20th and 25th, sometimes not until the 28th or 30th. Eggs are laid at once when the females appear. This brood scarcely

lasts beyond the middle of August, and shortly thereafter, generally between the 20th and 28th of this month, the last brood appears. As early as the first of September the female is laying her eggs, the male preceding her by only two or three days. Eggs are laid at least as late as the 20th and both sexes continue to fly nearly to the end of September, though in scanty numbers in the latter part of the month. The eggs of this brood hatch in from five to seven days and the young larva, as before, moults its embryonic skin in four days; as it is a comparatively rapid feeder it probably passes the winter as a chrysalis rather than a caterpillar. In Georgia Abbot bred the butterfly September 22, after ten days in chrysalis.

Behavior of the butterfly. It has a feeble flight, never darting about from one spot to another like other Hesperidae, but moving in a leisurely, languid manner, skipping over the grass-tops of a lane or among the reeds of a marshy rill, in the most dainty manner possible; it does not turn much to one side or the other, but flies with a short, slight, vertical movement apparently giving but a single beat of the wings to each little skip and frequently stopping to alight; it never rises above the herbage unless to alight on a flower. "When alarmed, they will drop to the ground among the grass stems and then remain quiet" (Maynard).

When perched on a flower all the wings diverge equally at an angle of 45° with each other. When resting the body is raised high and equally on all the legs, the wings folded back to back, all their costal edges together; the antennae, as seen from the side, are continuous with the plane of the body and straight, but curve slightly from a superior view and diverge at an angle of fully 140° , the tips being curved backward and separated by a distance of 9.5 mm. Often also, in the hot sunshine, the hind wings are placed at right angles to each other, while the fore wings are slightly parted only and dropped so as to bring the costal edges opposite the same margins of the hind wings. At other times, especially when resting in the shade, the hind wings are stretched horizontally or nearly so, while the fore wings diverge at an angle of 45° , their tips being 5 mm. apart, and the extremity of their inner margins resting upon the anal area of the hind wings; the antennae are then deflected a very little and diverge at an angle of about 125° , the tips being 8.5 mm. apart. When walking, all the wings are closed, the tip of the abdomen is trailed on the ground, and the antennae, retaining the divergence just mentioned, are straight on a lateral view and barely bent below the plane of the body.

It has a curious habit when at rest, of moving its antennae in a small circle, the motion of the two alternating, i. e., when one is moving in a forward curve, the other is passing in a reverse direction.

Desiderata. Although the history of this butterfly is better known than that of many others, there are some points which still remain obscure; in particular we know but little of the second brood and the cause

of its brief duration; probably it is comparatively insignificant in numbers and its history may prove a curious element in the life of the butterfly; how the insect passes the winter and what the duration of the chrysalis of each brood may be are questions still requiring solution. Nor have we any knowledge worth mentioning of the peculiarities and habits of the later stages of the caterpillar or of the structure of the chrysalis or cocoon. It would be interesting to know whether the mature caterpillar lives exposed, like the other species in this section. The parasites and the northern limits of the butterfly, even in New England, require investigation.

LIST OF ILLUSTRATIONS.—ANCYLOXIPHA NUMITOR.

- | <i>General.</i> | <i>Imago.</i> |
|--|--|
| Pl. 29, fig. 4. Distribution in North America. | Pl. 10, fig. 7. Male, both surfaces. |
| <i>Egg.</i> | 13: 13. Both surfaces. |
| Pl. 66, fig. 22. Outline. | 37: 1. Male abdominal appendages. |
| 25. Colored. | 42: 3. Neuration. |
| 69: 8. Micropyle. | 68: 5. Side view of head and appendages enlarged, with details of the structure of the legs. |
| <i>Caterpillar.</i> | |
| Pl. 73, fig. 4. Caterpillar at birth. | |
| 80: 51. Front view of head in stage I. | |

PAMPHILA FABRICIUS.

- Pamphila Fabr., Ill. mag. ent., vi: 287 (1807);
 —Scudl., Proc. Am. acad. sc., x: 236 (1875).
 Carterocephalus Led., Verh. zool.-bot. gesellsch. Wien., ii: 26, 49 (1852).
 Steropes Boisdu., Voy. Astruc, 167 (1832).
 Cyclophides pars Auctorum.

Type.—*Pop. paniscus* Fabr.

Doch Alles singt und blüht und leucht in Helle,
 Liebkosend grüßet der Lenz sein schönes Kind:
 Der Schmetterling, die gaukelnde Libelle,
 Das Bißchen naht, der laue Morgenwind,
 Und Alles trinkt aus ihrem duft'gen Quell.

SCHULZE.—*Die bezauberte Rose.*

Imago (58: 6). Head pretty large, clothed with short scales and three transverse rows of very long hairs; outside of the antennae a slender pencil of slightly spreading, nearly equal, arcuate hairs, directed outward, curving over the eye and reaching nearly to its centre. Front considerably tumid, scarcely twice as broad as long, its front border suddenly and greatly elevated, so that the whole front is brought nearly to the level of the vertex, and thus protruding excessively beyond the front of the eyes, especially anteriorly, separated from the vertex by a slightly impressed, straight, transverse line, connecting the middle of the anterior halves of the antennal bases; the middle third of the front margin is scarcely convex, laterally rounded off to the arcuate sides, which reach the outer border of the antennae; vertex considerably longer than the front, gently tumid, surpassing, in front more than behind, the level of the eyes, separated from the occiput by a very regular, brace-like, slightly impressed, transverse line, and having upon its summit a slightly impressed, gently arcuate line, crossing from a little behind one antenna to the other. Antennae inserted in the middle of the summit, their interior bases separated from each other by two and one-half times the diameter of their bases, the whole antenna about five-sixths the length of the abdomen, composed of twenty-nine joints, of which thirteen form the club, which is slightly less than one-third of the whole antenna, subcylindrical, depressed, subfusiform, but curved more anteriorly than posteriorly, largest a little beyond the middle, and there as broad as the length of three consecutive joints; the tip is blunt, slightly conical, and

the last joint fully as broad as the stalk; the middle joints of the stalk a little more than twice as long as broad. Palpi two and one-fourth times longer than the eye, rather slender, heavily but loosely clothed with long hairs on all but the protruding apical joint; basal joint very small, globose, as broad as long, and one-third the length of the middle joint; middle joint large, tumid, cylindrical, slightly arcuate, well rounded at either end, more broadly at base than at tip, three and one-half times longer than broad; apical joint inclined a little forward, exceedingly minute, though apparently several times longer than it is, from the long hairs which follow the direction of its length, nearly twice as long as broad, tapering bluntly, rounded at tip, its length scarcely equalling half the breadth of the middle joint.

Prothoracic lobes small, appressed, lamellate; when viewed from the front nearly as long as the shorter diameter of the eye, fully half as long again as high, subtriangular, the inner and inferior sides straight, the other rather broadly arcuate. Patagla large, the posterior lobe longer than the basal portion, and half its width, slightly arcuate, nearly equal, but tapering toward the rounded tip; the whole nearly as long as the breadth of the head.

Fore wing (42:2) twice as long as broad, the lower outer angle falling but little beyond the middle of the costal margin; costal margin rather strongly convex at the base, beyond faintly concave; outer margin well rounded above, straight below, the apex somewhat pointed. The costal nervure terminating a very little beyond the middle of the costal margin; the subcostal moderately distant from the costal margin, its second nervule arising at the middle of the wing; cell a little more than three-fifths the length of the wing; first branch of the median arising midway between the second and the base of the wing, and very far before the origin of the first subcostal branch; internal nervure brief, straight.

Hind wing elongate, triangular, less than half as long again as broad; costal margin strongly lobed at the base, beyond straight; outer margin strongly and pretty regularly rounded above, straight below, the anal angle well rounded. Median nervules widely separated at base, the first nervule arising much nearer the base than the subcostal fork.

Legs 2 3, 1. All the femora fringed beneath with somewhat spreading hairs, which decrease in length regularly from base to tip of joint; on the middle and hind femora the basal hairs are half as long as the femora itself; base of the tibiae furnished above with very few, distant, long hairs. Femora 2, 1, 3; tibiae 2, 3, 1; tarsi 3, 2, 1; fore femora of the same length as the hind pair and three-fourths the length of the middle femora; fore tibiae about four-fifths the length of the fore femora and two-thirds the length of the middle tibiae, which are scarcely longer than the hind pair; leaf-like appendage of the fore tibia greatly reduced, consisting of a slender, straight, tapering, pointed process, not twice as long as the breadth of the joint, but four times as long as broad, attached to the middle of the outer two-thirds of the joint, and scarcely surpassing half the distance thence to the tip; other tibiae armed at the tip with a pair of long and very slender spines; hind tibiae without the secondary pair of spurs but with a double series of a few, very distant, minute, delicate spines beneath. Tarsal joints 1, 2, 5, 3, 4, terminal scarcely longer than the third joint, but on the fore legs twice as long as the fourth; fore tarsi about two-thirds the length of the middle and a little more than half as long as the hind tarsi, scarcely shorter than the hind tibiae,—all furnished beneath with a triple row of minute delicate spines, the apical ones of each joint but little longer than the others; basal joint very nearly as long as the rest together, the second fully two-fifths the length of the basal joint. Claws small and pretty delicate, rather strongly curved, tapering. Pad moderate, transverse. Paronychii very slender, thread-like, half as long as the claw, nearly straight.

Upper organ of male abdominal appendages very small and slender; hooks longitudinal, conical, adjacent throughout; lateral arms forming an inferior sheath-like lamina. Clasps pretty large and broad, twice as long as broad, nearly equal, the tip very broadly rounded, an apical tooth arising from the lower margin, scarcely separate from the blade.

Egg. Hemispherical, more than half as broad again as high, the domed upper portion very faintly and vertically wrinkled, simulating ribs which do not quite reach the basal broadest part of the egg; surface in no part cross-lined or reticulate but uniformly punctate.

Caterpillar at birth. Head large, full, smooth, broadest below, narrowest above, a little higher than broad, well rounded at all points, of nearly equal depth throughout, posteriorly truncate. Antennae with the basal mammiform joint exceedingly short, scarcely protuberant, third joint slender, twice as long as broad, cylindrical but largest apically and rounded at the tip, the fourth joint minute, cylindrical, about twice as long as broad and shorter than the width of the third joint, the bristle very short and exceedingly fine. Body slender, equal, the first segment slightly the broadest, with a moderately slender, transverse, entire dorsal plate, the last with a few curving hairs not more than twice as long as the ranged bristles. These, which are slender, tapering, one-third as long as the segments, the apex enlarged so as to be as broad as the extreme base, are seated on papillae half as high as broad, and disposed on each side of the body as follows:—a laterodorsal anterior series, becoming supralateral on the thoracic segments, the bristles directed upward, and on the abdominal segments a little inward; an infralateral post-median series, the bristles directed outward and slightly forward on the thoracic, slightly backward on the abdominal segments; a stigmatal anterior series, the bristles directed outward and slightly downward and backward; and an infrastigmatal series of two to a segment, the bristles slightly divergent and downward directed.

A stigmatal series of crateriform disks on the thoracic segments so closely resemble spiracles that I was deceived by them and in a note on p. 11 of this work wrongly mentioned them as such.

Mature caterpillar. Head large, higher and broader than the body, the front rounded subquadrate, slightly narrow above, a little higher than broad, the summit slightly notched, each hemisphere with a somewhat independent curve. On a side view much broader below than above, the diminution in depth being mainly upon the upper two-fifths, the front much rounded; triangle extending much above the middle of the front, slender, half as high again as broad; surface delicately and shallowly rugulose with no papillae but with short and very scant and delicate pile. Ocelli six in number, four in a tolerably strong anterior curve, the upper two small, the lower two large, a fifth as large as the third and fourth and nearly on a line with them, opposite the base of the antennae, further removed from the fourth than the fourth from the first; the sixth which is as small as the first and second, and behind the fourth, forms with the latter and the fifth the right angle of a right-angled triangle. Labrum twice as broad as high, rectangular with rounded corners. Mandibles stout, chisel-edged.

Body elongated, very depressed, cylindrical, slender, tapering very gradually from the front of the second abdominal segment forward and quite as gradually from the fifth abdominal backward, the body terminating in a produced, slender, regularly rounded, depressed, paraboloid plate. The neck of the first thoracic segment is very short and less constricted than common among the Pamphilidi. The transverse dorsal plate of the same segment occupies the posterior half only of the segment and is inconspicuous, subfusiform, but of nearly uniform width and well rounded at the sides, the whole segment of about equal length and breadth and broadest just beyond the base. The third segment is considerably larger than the first, which more nearly approaches the head in width and height than it does the segment behind it. Abdominal segments divided by transverse sutures into five subsegments, an anterior broad and four narrower subequal sections, three of them together scarcely larger than the anterior, the third and fourth rather shorter than the second and fifth. Body covered with a sparse pile, consisting of short, tapering, finely pointed hairs seated on minute, abundantly distributed papillae, not more than twice the width of the base. Spiracles minute, short ovate, crateriform, as if seated on the summit of slight tubercles, that of the eighth abdominal segment larger than the others and somewhat higher upon the body. Legs short, stout, the last two joints rapidly tapering, the claw bent at nearly

a right angle. Prolegs very short and stout. The body is likewise provided with longitudinal, suprastigmatal and infrastigmatal series of minute, smooth, glistening lenticles, the suprastigmatal slightly in advance of the infrastigmatal, somewhat behind the spiracles, generally one to a segment in each row, but occasionally double, and not always uniform on both sides of the body; those of the infrastigmatal series are larger than the spiracles; there is also a transverse series of four equidistant lenticles on the hindmost section of the penultimate segment, the outermost aligned with the last spiracle; others are found on the sides of the first and second thoracic segments.

See also Fletcher's very excellent account of the external structure of this caterpillar, one of the best that have ever been given of any butterfly caterpillar (Can. ent., xx).

We come now to a genus which though rather poor in species is exceedingly widely spread. Closely allied to a group of insects peculiar to southern Africa and Madagascar it is found only in districts as far removed as possible from that; namely, in the northern half of the north temperate zone of both hemispheres and south of the tropics in western America. Three species are known in the Old World in a belt which extends across the continent between Lat. 45° and 60° N. Two occur in the New World, one in Chili, the other across the northern continent between Lat. 45° and 60° ; so that, contrary to what usually holds in groups common to the two hemispheres, the generic belt is included between exactly similar latitudes.

The butterflies are small with rather slender and particularly long bodies. The hind tibiae are not provided with the middle pair of spurs almost universally found among Hesperidae—a character by which this group can be at once distinguished from all other New England skippers. They are dark brown above, largely covered with roundish tawny spots, often confluent on the fore wings, and less frequent, independent spots on the hind wings; the spots have no apparent regularity and give the wings a blotched appearance. Beneath, the wings are paler, the spots of the fore wings blurred, but those of the hind wings enlarged and distinct, paler than the ground color and sometimes silvery.

The metamorphoses of one of the European species is known and one of the American partially. The European species is single brooded and hibernates as a larva, transforming to chrysalis early in the season as in Thanaos. Our New England species, however, appears to be double brooded. According to Meyer Diir, the European butterfly is restless and nimble and flies in light openings in forests and by the skirts of woods; our own affects similar spots, but is not particularly active. The European caterpillar feeds on Plantago and grasses, while ours appears to feed only on the latter.

The egg is an interesting object, belonging to a little group in which there is a passage from the structure in Pamphilidi generally to that of Hesperidi, the vertical ribs of the latter just beginning to appear, but without the cross lines, and the reticulation of the former to be lost.

The remaining stages, so far as known, are strictly Pamphilidan, but the caterpillar, which is slender and somewhat depressed, lives exposed much of its later life; it is darker or lighter with some longitudinal markings. I have never seen the chrysalis.

EXCURSUS LXI.—WHAT FAMILIES OF PLANTS ARE PREFERRED BY CATERPILLARS OF BUTTERFLIES?

And worms, that stretch on leaves their gray bodies,
Crawl from their bags and butterflies become.

DRYDEN.—*Pythagorean Philology*.

KNOWLEDGE of the food plants of the caterpillars of butterflies is of prime importance to one who wishes to study their life histories; for although some species are polyphagous, others are the most particular creatures in the world and will starve to death if they are not supplied with just what they want. That this is not always the easiest thing to learn may be inferred from the frequent mishaps with the most experienced. And it is no wonder they are sometimes at fault or at a loss, for the few butterflies described in the body of this work choose their food from more than one-third of the families of plants mentioned in Gray's Manual of our botany.

Fifty-two families are represented in the food plants of our caterpillars—say a hundred species, as far as their food plants are really known*; of these, thirty-two nourish only members of one of the four families of butterflies, and as a general rule are therefore of minor significance. Exception must here be made, however, to four or five of these; for instance, the Violaceae, which almost exclusively supply our Argynnidi with food; the Grossulaceae, on which no less than six of our Nymphalinae and especially the Vanessidi have been found; the Cyperaceae, on which several, very likely many of the Satyrids flourish; the Aquifoliaceae, on which several of our Lycaeninae, both Theclidi and Lycaenidi, feed; and finally the Lauraceae, a favorite food plant of the Papilioninae.

Twelve families of plants have been found to be the food of butterflies of two (and not more than two) families of our butterflies, but in most of these cases, they are only known as the food of single species in each family and so assume small importance. Yet among them are others in which the case is different. Thus the Rutaceae are known to serve as the food of about as many different species of Papilioninae as the Lauraceae, and they are said also to be among the food plants of Chrysophanus; the Betulaceae are a common food of several species of Nymphalinae and nourish also Jasioniades; while of the utmost importance are the grasses, upon which

* All suppositions or really doubtful cases are here left out of consideration.

nearly all our *Satyrinae* and *Pamphilidi* live—a good fourth of our butterfly fauna, even omitting the many *Pamphilidi* which doubtless feed upon grasses but which are not yet known in their early life.

The families which are chosen as food by members of more than two families of butterflies are always important. Five of them nourish members of three families, while three are chosen by some members of all four families. Of the first, the least important, but more significant in Europe than in America, are the *Urticaceae* (2 *Nymphalidae*, 1 each *Lycaenidae* and *Papilionidae*), followed by the *Cruciferae*, a favorite of the *Pierinae* and besides eaten by one of the *Lycaenidae* and one of the *Hesperidae*; and *Ericaceae* (2 *Nymphalidae*, 3 *Lycaenidae* and 1 *Papilionidae*). More important are the *Compositae* (8) which are especially eaten by *Melitaeidi*, but also by other *Nymphalidae*, as well as by *Lycaenidae* (2 species) and *Papilionidae* (1). But *Rosaceae* take the first place with those that support only members of three families, it being the known food of thirteen species, mostly *Nymphalidae* (6) and *Lycaenidae* (5) but also *Papilionidae*.

The families of plants fed upon by all four families of butterflies are three in number, and with the *Rosaceae* just mentioned and the *Gramineae*, the greatest supporter of caterpillar life, must be looked on as the favorite food of butterflies in their early stages. These are the *Cupuliferae* and especially the oaks which nourish eight species, mostly *Lycaenidae* and *Hesperidae*; the *Salicaceae*, the food of eleven species, five of them *Nymphalidae*, the others equally divided among the remaining families; and the *Leguminosae*, which vie for pre-eminence with the *Gramineae*, for twenty-three of our species are found upon it; of these, nine are *Hesperidae* (and perhaps exclusively *Hesperidi*), seven are *Lycaenidae*, five *Papilionidae* (exclusively *Pierinae* and indeed *Rhodoceri*) and two *Nymphalidae*.

More than one-third of our butterfly fauna is made up of the lowest, least known and most inconspicuous family, the *Hesperidae*, our members of one tribe of which feed almost exclusively on *Leguminosae* (a few on *Salicaceae*, *Cupuliferae*, etc.), of the other on *Gramineae*, and of course very decidedly affect the general result when all butterflies are considered. It is entirely owing to them that these two families take the first place, though they are by no means insignificant in their relation to the other families of butterflies. For leaving the *Hesperidae* out of consideration, the *Rosaceae* easily assume the first place and hold it alone, while the *Leguminosae* and *Gramineae* still retain such importance as to hold the second place, and indeed the highest position there, with the *Salicaceae*, *Compositae* and *Violaceae*, followed hard by the *Cupuliferae*, *Ericaceae*, *Grossulacae* and *Cruciferae*. These, then, are the preferred food of the caterpillars of our eastern American butterflies and where there is no clue from relationship or otherwise as to what the food plant of an unknown caterpillar may be, it is wisest to experiment with these.

PAMPHILA MANDAN.—The arctic skipper.

[Checkered skipper (Gosse); small black skipper (Maynard).]

Hesperia mandan Edw., Proc. entom. soc. Philad., ii: 20-21, pl. 5, fig. 1 (1863).*Heteropteris mandan* Kirb., Syn. cat. Lep., 634 (1871).*Cycloides mandan* Scudd., Syst. rev. Am. butt., 54 (1872).*Carterocephalus mandan* Edw., Cat. Lep. Amer., 49 (1877);—Fern., Butt. Me., 95 (1884);—French, Butt. east. U. S., 290-300 (1886);—Mayn., Butt. N. Engl., 57, text, not plates (1886).*Pamphila paniscus* Gosse, Can. nat., 219 (1840).*Carterocephalus paniscus* Streck., Lep., 69 (1874).*Hesperia mesapano* Scudd., Proc. Bost. soc. nat. hist., xi: 383-384 (1898).*Cycloides skada* Edw., Trans. Am. ent. soc., iii: 196 (1871).*Stereoptes skada* Edw., Trans. Am. ent. soc., iii: 214 (1871).

Figured also by Glover, Ill. N. A. Lep., pl. I, fig. 3, ined.

[Not *Papilio paniscus* Fabr.]

The grub would change to a butterfly—
Burst from his chrysalis, and appear
Like an English milord, with a million a-year.

STORY.—Giannone.

Imago (10:2). Head covered above with mingled black and greenish tawny hairs, the latter often dusky at their base; beneath at the sides with straw yellow scales, which pass up in a narrow band at the hinder edge of the eyes and reappear behind the antennae; tuft outside of the antennae black. Palpi whitish at base, pale canary yellow toward apex, paler in tint beneath, rather profusely furnished on the sides, very profusely above, with long black hairs; terminal joint black, yellow beneath; antennae purplish black above posteriorly, both in front and behind serrate with a tooth of tawny at the base of each joint, occasionally nearly uniting across the joints and forming on each an annulation; beneath pale tawny, the apical three-fifths of the club, on the sides as well as beneath, and the whole of the terminal joint naked and slightly deeper in tint. Tongue dark slate brown, luteous at extreme base, growing a little paler toward tip.

Thorax covered above with dark brown hairs, tinged, most deeply on the prothorax and patagia, with greenish tawny; beneath with dirty yellowish, or pale tawny hairs; legs tawny buff, the basal half of the femora pale, the upper surface of the tibiae and under surface of the tarsi darker, and the upper surface and sides of the tarsi dark, purplish brown, deepest toward their tips; spurs dull buff, dusky tipped; spines luteo-buff; claws dull reddish, dusky tipped.

Wings above very dark brown, tinged with chocolate and marked with tawny. Fore wings with a few tawny hairs close to the base in the principal interspaces. There is a large tawny spot occupying nearly the whole of the cell; its external margin is straight and runs from midway between the bases of the second and third superior subcostal nerves to the base of the second median nervule; in the middle of the cell the spot is encroached upon by a deep, semicircular incision, reaching from above nearly to the median nervure, leaving that portion of the spot which lies outside of it nearly square; toward the base, the spot occupies only the lower half of the cell, tapers and terminates midway between the first divarication of the median and the base of the wing; beneath the median nervure and just beneath the excision, the spot is slightly enlarged by a small, triangular, tawny patch at the extreme base of the lower median interspace, but separated from the cellular spot by the nervure. In the middle of the outer half of the wing is a transverse, continuous, rather broad, arcuate series of angulated tawny spots, separated only by the nervures and subparallel to the outer margin, excepting in the two interspaces beyond the cell, where they are removed outward, their interior margins continuous with the exterior margin of the rest of the

wing; the band is slightly broader than the width of the cell, excepting beyond the cell, where it is slightly smaller, and extends from just below the extreme costal margin to the submedian nervure, in the interspace above which the spot is divided longitudinally into two nearly equal rhomboidal patches, the outer border of each sloping toward the middle of the interspace; in the lower half of the same interspace, midway between the spot and the base is a small, roundish, tawny spot; edge of outer border blackish. Basal half of fringe blackish, outer half dull olivaceous-tawny. *Hind wings* with a small, oval, longitudinal spot in the middle of the upper two-thirds of the cell, a large, roundish one at the extreme base of the two interspaces beyond the cell and occupying the whole of their width; a third, similar in size and shape to the cellular spot, but sometimes a little more elongated and often less distinct, in the lower median interspace, its outer limits in the centre of the interspace; a fourth and similar one is usually found in the interspace above the large spot, its internal border as far from the outer margin of the wing as the external border of the latter; there is, besides, a submarginal series of very small, round spots, often wholly or partially obsolete, extending from the subcostal to the submedian nervures, midway between the previously described spot and the outer margin in the uppermost interspace, and receding very slightly from the border in passing downward. Edge of outer border scarcely marked with black. Fringe rather pale, tawny yellow, the basal half or third pretty deeply obscured with blackish.

Beneath tawny buff, marked with dark brown. *Fore wings* with the extreme base of the cell, a semicircular spot in the middle of its upper two-thirds, the basal half of the medio-submedian interspace, excepting a very small space in the middle of the lower half, and a roundish spot close to, but not at, the base of the lower median interspace, dark brown; besides there is a rather large quadrate spot twice as long as broad, occupying the basal half of the interspaces beyond the cell and the extremity of the cell itself, but enlivened at the nervures which terminate the cell by a transverse stripe of yellow, a color which sometimes powders also the parts beyond; its interior third is surmounted by a dark triangular patch which reaches the costal margin, where it is broadest. Beyond is a transverse series of dusky quadrate spots separated by little but the nervures, subparallel to the outer border, but approaching it below because broader there than above; the interior limit of the band is continuous with the exterior limit of the spot in the interspaces beyond the cell, but in these same interspaces the band is represented only by two very small, roundish spots, or by slender lunules, the interior limits of which are on a line with the exterior limits of the rest of the band; the outer half of the costal margin is very narrowly black-edged, as is the whole outer margin, where it develops dots on the nervures. Fringe very dark fuscous, paling toward the tip on the basal half, slightly enlivened by tawny scales. *Hind wings* with three rows of obscurely black-edged spots: the innermost, in the middle of the basal two-thirds of the wing, consists of two very large, silvery white, longitudinally oval spots, occasionally tinged with yellow, one in the middle of the cell, the other just before the middle of the costo-subcostal interspace; the next series, in the middle of the outer two-thirds of the wing, consists of a straight, transverse series, subparallel to the first, of three unequal, roundish spots, the largest, usually the largest spot in the wing, traversed in the middle throughout its breadth by the nervules closing the cell; the smallest, next to it and less brilliant, in the lower median interspace opposite the second divarication of the median; the lowest, midway in size between the two and sometimes greatly elongated, lies in the medio-submedian interspace, its interior limit in the middle of the interspace; the third series is a submarginal one of small, roundish, or semicircular spots, yellowish or tawny, tinged with whitish or occasionally with silvery, occupying all the interspaces from the costal to the submedian nervures, the spots equal and as large as the middle spot of the previous series, excepting that in the upper subcostal interspace, which is twice as large as the others and on a line with the spots of the middle series. Fringe dark tawny, paler toward the inner angle, the basal half on the upper two-thirds of the wing obscured with fuscous.

Abdomen blackish on the upper half, more or less enlivened with tawny scales; beneath tawny, at the base of the wings, and especially along the lateroventral line,

marked with blackish; the terminal hairs of the body reddish tawny. Upper organ of male appendages (37:2) with the centrum a little convex, slightly compressed; hooks as long as centrum and together as broad as the base, regularly conical, straight, bent strongly downward. Claspers about two and one-fourth times longer than broad, quite as broad at apex as at base, the upper edge sinuous; apical tooth small, compressed, laminate, not pointed, central, interior, curved slightly inward. It differs from *P. palaemon* of Europe in that the apical tooth of clasp is bent inward a little less, in the greater stoutness of the upper organ and of each of the parts, and in having the hooks much more strongly bent downward, forming a considerable angle with the lateral arms.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 9.5 mm.						
Length of fore wing.....	12.25	12.5	13.5			
antennae.....	6.	6.				
hind tibiae and tarsi..	5.65	6.15	6.15			
fore tibiae and tarsi...	3.25	4.	3.95			

Described from 3 ♂.

Egg. In their widest parts the vertical wrinkles are about .06 mm. apart; surface densely and uniformly punctate with very distinct, short oval punctures, whose longer axis is vertical and about .003 mm. in length, arranged to a certain extent in short, irregular, sinuous series, giving a faint vermiculate effect. Diameter of egg, .86 mm.; probable height, .48 mm.; punctae about .008 mm. in diameter. Described partly from a shell from which the caterpillar had escaped, partly from alcoholic specimens. Color, according to Fletcher, greenish white.

Caterpillar. *First stage.* Head piceous, the surface almost smooth, with a very few scattered, short, tapering hairs. Mouth parts testaceous. Body uniform very pale lemon, the dorsal thoracic shield piceous, the hairs pellucid and one-third as long as the segments. Legs slightly infuscated. Prolegs color of the body. Spiracles luteous. Length, 2.5 mm.; breadth of head, .45 mm.; of body, .35 mm.; length of bristles, .05 mm. Duration of this stage, according to Fletcher, five days.

Second stage. "Head white and furrowed at apex. Thoracic shield black, much smaller than in first stage. Body pale green with two narrow white lines on each side, one subdorsal, the other supralateral. Spiracles yellowish. Whole body covered with a minute pubescence. Duration of this stage five days." Length, 3.5 mm. (Fletcher.)

Third stage. After second moult. "Head rather higher than broad, slightly broadest at the base, rounded at apex and bilobed by reason of a deep frontal groove; mandibles and two clouds on the cheeks, fuscous. Thoracic shield transparent and hardly discernible. Body pale green and translucent, the dorsal vessel and the ramifications of the tracheae showing plainly through the transparent skin. There are on each side, a pale subdorsal band with irregular edges, a distinct, clear white, supralateral stripe and a very faint suprastigmatal line. The subdorsal bands unite on the anterior fold of the anal segment. The supralateral stripes at the end of the anal flap. Duration of stage seven days." Length, 6.5 mm. (Fletcher.)

Fourth stage. Head pale green with a bluish tinge, obscured with very faint reddish fuscous in a broad mottled stripe bordering the suture above the frontal triangle, and in a similar belt passing down the middle of each hemisphere from the posterior point of the former toward the ocelli, but fading out before reaching it; hairs white; ocelli black; mouth parts pinkish at incisures and edges. Body very pale yellow, nearly uniform, the dorsal shield of first thoracic segment of the color of the head, with a median dusky line through it; last abdominal segment finely edged with fuscous and a little obscured above; an exceedingly faint, slender, greenish, dorsal stripe and a slightly wider, but otherwise entirely similar, lateral stripe the whole length of the body. Legs and prolegs concolorous, their claws and the spiracles lips pale testaceous. Papillae concolorous, hairs pale brown. Length, 8 mm.; breadth of head, 1.25 mm. This stage lasted, in Mr. Fletcher's specimen, fifteen days.

Last stage. Head uniform green; labrum black; mandibles castaneous at base and black at the edge; the other mouth parts much infuscated. Ocelli black at base.

Body uniform cream color with a faint, rather broad, darker, dorsal stripe and a slenderer, distinct, pale yellowish stripe extending the entire length of the body. Blackish fuscous spots are found along the stigmatal line and somewhat irregularly beneath the lateral band at the posterior limit of each segment. Papillae concolorous with the body, the hairs generally pallid but sometimes infuscated and generally curved forward. Integument very finely shagreened. Legs with the claw and the apex of the penultimate joint black or blackish. Prolegs greatly infuscated, especially apically and upon the outside. Spiracles black, set in a small black field surrounded with a fusco-ferruginous areola. Length of the body, 21 mm.; breadth of the same, 2.8 mm.; of head, 1.8 mm.

Distribution (29:5). This butterfly is interesting as being our only subarctic skipper (unless *Erynnis manitoba* may lay some claim to such distinction), a member of both the Canadian and Huronian faunas, and though found in comparatively few localities has an immense distribution, almost wholly in the dominion of Canada, where it has been found at Anticosti and southern Labrador (Couper), Godbout rare (Corneau), Lake Mistassini (Fletcher), Quebec (Bowles), Bevan's Lake (D'Urban), Compton (Gosse), Ottawa (Billings), Bobcaygeon, Ont. (Fletcher), Moose, at the southern extremity of Hudson Bay, common (Haydon, teste Weir), St. Joseph's Island and Sault St. Marie, Lake Superior "quite common" (Bethune), Nepigon, not uncommon (Fletcher, Scudder), Lake Winnipeg (Edwards), Rocky Mountains (Brit. Mus., and more recently Macoun), Lake La Hache (Crotch), Vancouver Island (Fletcher) and Alaska (Edwards). It has also been found in our own territory in California* (Behrens), and Edwards also states that it occurs in New York, probably in the Adirondacks.

It occurs also, in New England, being not uncommon in the higher valleys of the White Mountains, as along the Glen road and along the roads into the ravines and through the notches in the vicinity of Crawford's and of Fabian's (Sanborn, Scudder and others); and further, at Norway (Smith) and Lake Chimo, near Bangor, Me. (Braun).

Oviposition. The only eggs I have heard of were those obtained by Mr. Fletcher and myself at Nepigon, where an enclosed female laid a couple of eggs on grass. Mr. Fletcher also raised the larva from one gently pressed from the oviduct of the same moribund female. The eggs hatch in ten or twelve days.

Food and habits of the caterpillar. Not only were the eggs laid by the female on grass, common lawn grass, *Poa pratensis*, but the caterpillar was carried to maturity by Mr. Fletcher on the same, while females caged over plantain, *Plantago*, on which the allied *Pamphila palaemon* is said to feed, refused to lay eggs thereon. Moreover, when the caterpillars hatched, one was placed by Mr. Fletcher on grass and one on plantain;

*By accident the color on the map intended for this point has been carried too far east.

the former at once made a nest in a blade (as did one I hatched), while the one placed on plantain "wandered all over the glass and would not touch the plantain." Removed to grass it at once began to make its nest. Its true native food plant is yet to be discovered.

Food plants and habits of caterpillar. My account of these must be drawn entirely from the observations of Mr. James Fletcher, the only one who has raised the caterpillar to maturity (Can. ent., xx.). "These larvae fed freely on all grasses offered to them but seemed to prefer wide-leaved species. . . . The favorite grasses were *Panicum crus-galli*, *P. sanguinale* and *Triticum repens*." This choice, Mr. Fletcher thinks, "may have been an instinctive preference for protection, both from the shape of their bodies and the coloration, added to a habit of lying extended down the midrib with the body closely appressed, the lower part of the head protruded and the apex drawn back, these larvae are well hidden from observation."

When his eggs were about to hatch, Mr. Fletcher put one on plantain and one on grass; the latter, when born, set to work at once and spun a small tent of two or three cords of silk attached to the edges of the grass blade. The next morning the leaf was found eaten at tip considerably. The other on plantain wandered all over the glass under which all were enclosed, and would not touch the plantain. When removed to the grass with a paint brush, it at once set to work making its tent. It seems plain, therefore, that our species will not eat plantain as the European species is said to do, a point which now seems to me to require corroboration.

I recorded in my notes that "on hatching, the caterpillars at once tie themselves up in the tip of a blade of grass by fastening together the opposite edges by two or three thickened and somewhat distant strands of silk." Mr. Fletcher uses almost the same expression:—

Directly after they hatched the young larvae climbed up to the tops of the blades of grass and made a sort of tent by catching the opposite edges together with two or three cords of silk, about half an inch below the tip. They then attacked the edges of the leaf, eating down on each side and leaving the midrib.

From the very first [he adds, they] were great wanderers, frequently leaving their food plant and crawling all over the glass lamp chimney, which was used as a cage. In these wanderings they spun silken paths wherever they went, and to prevent their escape a plug of cotton wadding was kept in the top of the chimney. This habit of wandering was kept up through all the stages and the inside of the glass was covered with their silken paths. At no time however did they construct a tent by catching several leaves together. . . . When at rest during the first three stages they retired beneath their tents and lay extended along the midrib. After the third moult they would sometimes roll the leaf of a wide species of grass as *Panicum crus-galli* into a tube similar to those [made by *Atrytone zabulon*. After the fourth moult no tent was made, the larva lying exposed on the upper surfaces of the leaves].

The full grown larva measured one inch and one-eighth on September 12 (twelve days after the last moult). After this it fed sparingly for about two weeks and then spun a mat of silk on the face of a blade of grass and drew two other blades over it with single strands of silk. The furrow down the face deepened and appeared to

open a little and I felt sure pupation was going to take place. This, however, was not the case, and two days later the larva left the grass and spun another mat on the sloping side of the lamp chimney. It now ceased to eat and the colour changed gradually, all the green fading out and in ten days the body was of a yellowish cream colour with white stripes. This again darkened until the ground colour was a very pale brown or dove colour. The moisture which condensed on the side of the glass kept the lower part of the larva's body constantly wet; but I did not like to risk removing it as I looked for pupation at any day. After remaining still and evidently in hibernation for about five weeks I found it had fallen from its mat to the ground on 29th October. After about a fortnight discoloured spots began to appear and I found it was dead.

Life history. The dates of capture of this butterfly indicate that it is probably double brooded, at any rate along its southern boundaries. It appears about the White Mountains toward the end of the first week in June, emerging in scanty numbers from the 5th to the 7th. Butterflies continue to be found in a fresh condition until the middle of the month, when they become scarce, and how long they fly is uncertain. At Nepigon they were found in such condition in the first week in July as to indicate that they did not fly there before this month. Eggs were laid about the 10th, hatching in less than a fortnight. These specimens, reared by Mr. Fletcher, passed their first moult about the 1st of August and did not attain their full size until the middle of October, when they apparently went into hibernation, though the single specimen carried to this stage died before the end of the month, as noted above. It is probable, therefore, that winter is passed as a mature caterpillar, which the time of appearance of the butterfly in the spring renders more probable. This indicates certainly that as far south as Nepigon, which, however, by its climate, strictly belongs to regions much farther north, there is but a single brood; but Mr. Bethune found butterflies at Sault St. Marie between August 10 and 24 in considerable abundance, which indicates that at its extreme southern limits, the butterfly appears a second time upon the wing. The difficulty in the case, however, is that it has never been taken in the White Mountains later than June, and this is one of the southernmost localities in which it occurs.

Habits of the butterfly. This butterfly is to be found most commonly on flowers by the sides of roads, through thickets or woods, especially the latter, if they are open enough to let the sun enter freely. It is a feeble flyer for an Hesperian, keeping only two or three inches above the ground in the roadways, much like *Thanaos icelus*.

At rest, the wings are held erect and almost attingent, the antennae on a plane with the body, divaricate at an angle of about 135° , the curved tip in the same plane with the rest; the trunk is raised at a slight angle with the surface of rest.

Desiderata. Although, thanks to Mr. Fletcher's care, we now know most of the early stages of this insect and the habits of the caterpillar, we

do not yet know the chrysalis, nor the natural food plant selected by the insect, nor just how the winter is passed. The habits of the butterfly need more attention, and particularly its distribution, which is the more important, from its being our northernmost type of skippers.

LIST OF ILLUSTRATIONS.—PAMPHILA MANDAN.

- | | |
|--|--|
| <i>General</i> | Pl. 37, fig. 2. Male abdominal appendages. |
| Pl. 29, fig. 5. Distribution in North America. | 42: 2. Neuration. |
| <i>Imago.</i> | 58: 6. Side view of head and appendages |
| Pl. 10, fig. 2. Male, both surfaces. | enlarged, with details of leg structure. |

AMBLYSCIRTES SCUDDER.

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|---|---|
| Amblyscirtes* Scudd., Syst. rev. Amer. butt.,
54 (1872). | Hesperia pars Auctorum.
Pamphila pars Auctorum.
Type.— <i>Hesperia vitalis</i> Edw. |
|---|---|

O sieh nur, wie der Lenz sich freut,
Dein Kindlein zu begrüßen,
Und Blüten auf die Pfäde streut
Zu deines Liebbling's Füßen.

Er schwärmt als Schmetterling im Flug
Dem Kindlein um die Locken,
Als hielt er sie in süßem Trug
Für duft'ge Blütenglocken.

STURM.—*Der Mutter.*

Imago (58:7). Head large, furnished with short scales and heavy, transverse masses of long hairs; at the exterior base of the antennae a moderately long, spreading tuft of curving bristles, directed forwards and outwards, the length equalling about one-third of the semi-circumference of the eye. Front considerably tumid, considerably and roundly elevated in advance, so as to bring nearly the whole front almost to the level of the vertex, and hence surpassing considerably the front of the eyes; the sides beyond the inner margin of the antennae scarcely partake of this tumidity and are separated from the middle portion by a distinct, slightly sinuate sulcation; fully twice as broad as long, separated from the vertex by a straight, transverse sulcation, slightly in advance of the middle of the antennae; the middle portion of the front border scarcely concave, laterally well rounded off and forming with the sides a regular curve to the outer margin of the antennae. Vertex a little tumid, elevated considerably and regularly above the level of the eyes, transversely flat in the middle three-fourths, nearly twice as broad as the front, separated from the occiput by a scarcely perceptible, brace-like mark. Eyes large, pretty full, naked, more broadly rounded behind than in front. Antennae inserted with the hinder edge of the base in the middle of the summit, their interior bases separated by more than twice the diameter of the basal joints, the whole antenna somewhat longer than the abdomen, composed of thirty-three to thirty-five joints, of which nineteen form the club, which is more than one-third of the antenna, and is bent beyond the middle of the outer half, at the neighborhood of the twenty-fourth joint; it increases in size up to the twenty-first joint, where it is fully equal in width to the length of two joints; from here it tapers regularly and rapidly to a point, the twenty-ninth joint being equal in diameter to the slender stalk; the club is subtriangular, slightly compressed, the crook bent at right angles backward; the joints at the middle of the stem are about three and one-half times longer than broad. Palpi rather stout, a little more than twice as long as the eye, the basal two joints very heavily clothed with long,

**apollis, eximius*, a dull-colored skipper.

loosely compacted, curving scales and hairs, which are rather abruptly cut off at the tip of the second joint, beyond which the apical joint, clothed only with recumbent hairs projects; basal joint rather small, tumid, somewhat cup-shaped, the apical portion considerably produced anteriorly, as long as broad, nearly half as long as the second joint; middle joint ovoid, scarcely twice as long as broad, a little arcuate, more broadly at base than at tip; the apical joint long, slender, straight, perfectly cylindrical or very slightly conical, the tip bluntly pointed, fully three-fourths the length of the middle joint, and about five times as long as broad.

Prothoracic lobes moderately large, appressed, laminate; viewed from the front semilunate, the base nearly straight, not twice so long as high, and about as long as the longer diameter of the eye. Patagia pretty large, the posterior lobe longer than the base, fully half as broad as it, scarcely tapering, broadly rounded at the tip, the whole nearly as long as the breadth of the head.

Fore wing (42:4) considerably less than twice as long as broad; the lower outer angle falling but little beyond the middle of the costal margin; costal margin well rounded at base, but beyond quite straight; the outer margin regularly and considerably convex, the tip not at all produced. Costal nervure terminating in the middle of the costal margin; subcostal nervure moderately distant from the margin, the third nervure arising at the middle of the wing; cell three-fifths the length of the wing, almost equally broad in the whole apical half; first median nervure arising a little more than half way from the base to the second and at considerable distance before the origin of the first subcostal branch; internal nervure straight, brief.

Hind wing shaped in general much as in *Pamphila*, rather more prominent apically in the subcostal region; only one-fourth longer than broad. Subcostal and median nervures first forking at nearly equal distances from the base and far before the middle of the wing; the second median nervure arising at about the middle.

Legs 2, 3, 1. All the femora furnished beneath with a slightly compressed fringe of hairs, which decrease a little in length from the base toward the tip and are longer on the middle and hind femora than on the fore pair; hind tibiae furnished above with a few long hairs. Femora 2, 1, 3; tibiae 2, 3, 1; tarsi 2, 3, 1. Fore femora slightly longer than the hind and nearly as long as the middle femora. Fore tibiae less than two-thirds the length of the hind femora, which are scarcely shorter than the middle tibiae and of about the length of the hind tibiae. Leaf-like appendage of the fore tibiae small, slender, about four times as long as broad, largest just beyond the base, slightly tapering and pointed, originating in the middle of the apical four-fifths and surpassing the extremity of the tibia but a little; other tibiae furnished at tip with a pair of long and slender spurs, the hinder femora with a secondary, exactly similar pair on the middle of the apical four-fifths of the joint. Tarsal joints 1, 2, 3, 4, 5, the terminal slightly longer than the penultimate on the fore legs; fore tarsi four-fifths the length of the hind tarsi, which are scarcely shorter than the middle ones; all with a triple series of delicate spines beneath, the apical ones of each joint much longer than the others; basal joint as long as the second, third and fourth united, a little longer on the fore legs; second nearly half as long as basal joint. Claws small and delicate, bent strongly in the middle, tapering. Pad moderately large. Paronychial slender, lanceolate, as large as the apical half of the claw, straight.

Upper organ of male abdominal appendages small, compact, directed straight backward, reaching to the middle of the distal half of the clasps, of about equal breadth and height, twice as long as broad; lateral arms fully as stout as the double hook and like it extended horizontally. Clasps stout, scarcely convex, subquadrate, twice as long as broad, the lower posterior angle rounded, the upper one slightly pointed.

Egg. Rather low, broadest at the base, broadly and regularly rounded, not flattened above; surface covered by very faint, delicate, raised lines, enclosing pretty regular, polygonal cells. Micropyle marked with a most irregular set of multitudinous, delicate, raised lines.

Caterpillar at birth. Head much broader and very much higher than any part of the body, rounded, subtriangular, pyramidal, faintly notched above, with an impressed

frontal incisure. Body very slender, uniform; first thoracic segment with an equal, narrow, transverse shield, reaching on either side to just above the spiracle; the dermal appendages slender, with a scarcely perceptible thickening at tip, arranged on the abdominal segments as follows: a subdorsal series on the anterior portion of the segment; a lateral series in the middle of the segment; a suprastigmatal series just in advance of the middle, and an infrastigmatal series just behind the middle, one to a segment in each series; on the thoracic segments the arrangement is the same, excepting that the subdorsal series becomes supralateral and is placed in the middle of the segment; the sides of the second and third thoracic segments with a blister-like spot in the middle; last segment with four recurved tapering hairs as long as the extreme width of the body; spiracle of the eighth abdominal segment much elevated and placed on the lateral line, being much higher than on the preceding segments.

Mature caterpillar. Head rugose, of equal width with the body, square and scarcely narrowed below, domed and subpyramidal above, with a slight but distinct median notch, considerably higher than broad, appressed; on a side view conical above the lower third, the summit rounded; triangle half as high again as broad; labrum deeply and roundly emarginate; on either side of it, the interior angle of the head just next the base of the triangle is produced to form a conical, pointed, slightly incurved, horny spine, as long as the labrum. Ocelli five in number, four in an anterior, vertical, curving row, equidistant, and one posterior, as small as the interior two of the row. Mandibles massive, not serrate.

Body equal in breadth throughout; the first thoracic segment scarcely smaller, with a very narrow, almost linear shield, in a fold reaching nearly to the stigmata and broken in the middle; the last abdominal segment not at all narrowed, but considerably flattened and declivent, very broadly rounded and almost truncate posteriorly; the other segments with a very broad, anterior subsegment, almost as broad as the other five subequal, plicate subsegments, and with the posterior part of its own area marked off to an equal width to form a more or less distinct subsegment. The body is rather broader than high throughout, highest in the middle and flattened beneath, so as to nearly conceal the short legs and prolegs. Legs rather heavily haired on the under surface.

Chrysalis. Long, slender and cylindrical, more than four times as long as broad, with scarcely distinct thoracic and abdominal swellings; head somewhat protuberant, with distinct, rounded, frontal and ocellar swellings, the sides straight and slightly narrower than the thorax. As seen from above, the sides of the body are nearly parallel, broadest near second abdominal segment, the last four abdominal segments tapering conically to a much depressed, slightly falcate cremaster, its edge and especially its apical edge, studded with hooks in the same plane. Thoracic spiracle large, obovate, but scarcely protuberant, only convex. Wings reaching the middle of the fourth abdominal segment; tongue to the proximal edge of the eighth. Position of the prolegs of the larva marked by callous protuberances, beset with short, spinous hairs.

This genus is confined to North America between Lat. 15° and Lat. 50° N., excluding the Antilles. A single species is found at Tehuantepec, another in the arid regions of Arizona, while two others extend over the greater part of the eastern United States, one of them crossing the continent, and occur throughout nearly the whole of New England, never, however, in any great abundance.

The butterflies are among the smallest of the Hesperidae, very dark brown, the outer half of the fore wings with a few pale spots, and the under surface of the hind wings heavily powdered with pale scales and sometimes with small scattered pale spots; the fringe is always interrupted, pale and dark. They frequent open spots and when at rest assume the Pamphilidan attitude.

Their transformations are tolerably well known for Pamphilidi. The species are single brooded in the north, probable double brooded or multiple brooded in the south and presumably hibernate in the chrysalis. The caterpillars feed on Gramineae.

The eggs are low, hemispherical, well domed, white or greenish white.

The young caterpillars have a high, pyramidal, black head and white or greenish white body, with dermal appendages in four rows and long recurved hairs on the last segment. The mature caterpillar is green with a very high and narrow, pyramidal, longitudinally banded head, and both head and body covered with a white, wooly floeculence, renewed after each moult when the skin is seen to be very delicate and transparent.

The chrysalids are very slender and cylindrical, covered with a white mealy powder, the tongue reaching the eighth abdominal segment, the front of the head broadly rounded.

EXCURSUS LXII.—COLOR RELATIONS OF CHRYSALIDS TO THEIR SURROUNDINGS.

This dull chrysalis
Cracks into shining wings, and hope ere death
Spreads more and more and more, that God hath now
Sponged and made blank of crimeful record all
My mortal archives.

TENNYSON.—*St. Simeon Stylites.*

It has long been known that there is in many instances considerable variation in the color of the chrysalids of certain butterflies and that in not a few instances we find a dimorphism more or less accentuated. The most frequent difference that has been noticed has been the prevalence on the one hand of green tints, on the other of dark gray or brown. Now when we recall that the commonest places chosen by caterpillars of butterflies for pupation, are either amongst the foliage of the plant on which they have fed, or on the other hand pendent from, or attached to, the twigs or trunks of trees with their gray bark, or to stones whose general color is dark gray or brown, we notice that we have here general tints of much the same contrast. When we further observe that the green color prevails in the chrysalids of those species which commonly transform upon their food plant and brown or gray in those which seem to prefer the background of bark or rock, we are struck at once with the protection which such resemblance must afford to chrysalids in general. And this conclusion would be very much strengthened were we to review the various minuter peculiarities of coloring and of sculpture which one may easily find. One of the most curious of these is noted by Fritz Müller, who says that the appendages on the chrysalids of *Eueides*, which hang horizontally on the under side of leaves, resemble the fungi which attack insects and which are found in precisely similar places. Another instance would be found in the sharp angu-

larities of many chrysalids among the Nymphalidae, combined with their frequent brilliancy by reflected colors, golden or nacreous, which, in combination, would be strikingly similar to the metallic gleam of angular minerals in the rocks which form their natural background.

This last circumstance, to which attention has been specially called by a very painstaking experimental entomologist of England, Mr. E. B. Poulton, led him to a careful inquiry into the cause and extent of the special color relations existing between the chrysalids of butterflies and their surrounding surfaces (Phil. trans., clxxviii: 311-441, pl. 26). He has been able to obtain almost at will chrysalids of different colors, according to the tints with which he has surrounded them, and so has opened a new field of experimental inquiry which may yield important, as it already has interesting results. By carefully selecting the time at which his experiments were made he has been able to determine that in all the species experimented upon it was only necessary to confine attention to that period in the later larval life of the insect, when it has ceased feeding and remains motionless, together with the early portion of the next period, after spinning the silken pads and shrouds for the pupal attachments until it has thrown off the larval skin. It had already been pointed out by Meldola that it was impossible to suppose the moist skin of the freshly formed pupa photographically sensitive to the color of the surrounding surfaces, and this has been made perfectly evident from the experiments of Poulton, which show that the color is determined before the assumption of the pupal state, since experiments made later than the time mentioned produced absolutely no results. Neither was Poulton successful, as he seems to have expected to be, in preventing the influence of surrounding objects from reaching the nervous centres through the ocelli of the caterpillar. All his successful experiments came when applied to that period of the transformation to which we have referred.

Most of the experiments were made upon three species, *Aglais urticae*, *Mamecia brassicae* and *Pieris rapae*. The experiments consisted in preparing for the creatures during their changes, artificial surroundings of different colors, green, orange, black, white and gilt. Over seven hundred chrysalids in all were experimented upon and it was found that with *Aglais urticae* green and orange surroundings caused no effect on the pupal colors, black produced as a rule dark chrysalids, while white produced light colored ones, many of the last being brilliantly golden; this suggested the use of gilt surroundings, which were far more efficient than white and produced chrysalids of a distinctly golden color, more so even than often occurs in a state of nature. The influence of black was curiously shown by the fact that when the caterpillars changed to chrysalids upon light surfaces, those which underwent their transformations in close proximity were darker than those that were more isolated, the color of each being

affected by that part of the surroundings which were made up of the dark skins of its neighbors. In endeavoring to discover whether the sensitiveness of the chrysalids to their surroundings was due to the general surface of the skin as a whole or only to that of one portion, experiments were made in tubes, part of which were colored black and part gilt, and the two parts separately by a diaphragm only permitting the body to pass through; by reversing the condition and making experiments with a large number of chrysalids, it became plainly evident that the color influence acted on some element of the larval skin and that the larger the area of the skin exposed to any one color the more the chrysalis followed its influence.

The nature of the effects produced is thus described by Poulton:—"The colouring matter of the dark pupae is contained in a thin superficial layer of the cuticle; below this is a thicker layer divided into exceedingly delicate lamellae, between which fluids are present, and the latter form the thin plates which, by causing interference of light, produce the brilliant metallic appearance. The thinner upper layer, being dark, acts as a screen in the dark pupae. Precisely the same metallic appearances are caused by the films of air between the thin plates of glass which are formed on the surface of bottles long exposed to earth and moisture. Both have the same spectroscopic characters and the same transmitted colours (complementary to those seen by reflection). The brilliancy of the cuticle can be preserved in spirit for any length of time; it disappears on drying, but can be renewed on wetting (this had been previously known), and the colours are seen to change during the process of drying, and when the cuticle is pressed, for the films are thus made thinner. The same lamellated layer exists in non-metallic pupae of other species, and is used as a reflector for transparent colouring-matter contained in its outer lamellae. Thus the structure which rendered possible the brilliant effects due to interference probably existed long before these special effects were obtained, and was used for a different purpose."

It has long been known that many of the chrysalids of the *Vanessidi* which yield parasitic *Ichneumonidae* in place of their proper inhabitants are frequently gilded; which is to be explained, in Poulton's view, from the abnormal state of the larva, which prevents the formation of pigment in the chrysalis. In this instance the gilded appearance is preservative not of the creature itself but of one of its foes, and does not appear a very wise provision of nature.

These experiments were made principally upon *Aglaia urticae*; others upon the different species of *Pierinae* were quite similar, the influence of black surroundings being to produce dark chrysalids and the greater the illumination the darker the chrysalids, this last result being the reverse of that obtained in the *Vanessidi*; white produced light chrysalids; and

the greater the illumination the lighter the chrysalids; dark red produced dark chrysalids; deep orange very light green chrysalids; pale yellow and yellowish green produced rather darker chrysalids than the orange; and bluish green much darker, while dark blue produced still darker chrysalids.

There is thus seen to be a certain difference between different kinds of chrysalids, as to the effect of the color of their surroundings, some being decidedly affected by colors which have no influence upon others. Probably a careful study of the natural conditions under which pupation takes place may lead to better comprehension of a fact at present not clearly explainable; and may bring other instances into harmony, as where, according to Fritz Müller, the chrysalids of a certain one of the swallow-tails, *evander*, are said to have both brown and green chrysalids, with no intermediate forms, and both produced under identical circumstances. Our own *Iphiaelides ajax*, in which dimorphism seems to be equally distinct, would serve as a good subject for experiment.

In concluding his account of his experiments on the *Pierinae*, Mr. Poulton observes (436-437) that "it must be remarked that the effect of the coloured surroundings upon the dark pigment is, perhaps, the least important part of the changes produced, for there are other consequences which seem to be much deeper in significance and far more difficult to understand. The black pigment patches and minute black dots are cuticular and superficial, while the ground-colours are sub-cuticular and deep-seated; and in the most brightly coloured pupae they are mixed colors due to the existence of different pigmentary (and probably chlorophylloid) bodies present in the different elements and at different depths of the sub-cuticular tissues of the same pupa. In other pupae no trace of such colors can be seen. Hence we see in these most complex and varied effects of the stimulus provided by the reflected light, which deepen into their permanent pupal condition very many hours after the stimulus has ceased to act, the strongest evidence for the existence of a chain of physiological processes almost unparalleled in intricacy and difficulty, while a theory of comparatively simple and direct photo-chemical changes induced by the stimulus itself without the intervention of such a physiological circle seems entirely inadequate as an explanation of the facts."

Table of the species of Amblyscirtes, based on the mature caterpillar.

Body with no conspicuous dorsal stripe.....	<i>violla</i> .
Body with a distinct dorsal stripe.....	<i>samoset</i> .

Table of species, based on the chrysalis.

Body pale pen-green, tinged at the extremity with luteous.....	<i>violla</i> .
Body yellow, tinged with green.....	<i>samoset</i> .

Table of species, based on the imago.

Base of median interspaces of fore wings with at most but exceedingly faint markings on upper surface, the lowest with none; extra-mesal series of pale markings on under surface of hind wings obscure, the whole wing flecked with lilac scales on a purplish ground....*vialis*.
 Base of median interspaces of fore wings with a series of pale markings on the upper surface, parallel to the costal margin; extra-mesal series of pale markings on under surface of hind wings distinct, the whole wing flecked with pale yellowish green scales on a dark brown ground.....*amoset*.

AMBLYSCIRTES VIALIS.—The roadside skipper.

[The roadside skipper (Seudder); two-spotted brown skipper (Maynard).]

- Hesperia vialis* Edw., Proc. acad. nat. sc. 348-349 (1886);—Fern., Butt. Me., 103-104 Philad., 1862, 58 (1862).
Pamphila vialis Kirby, Syn. catal. Lep., 608 (1871).
Amblyscirtes vialis Seudder, Syst. rev. Am. butt., 54 (1872); Butt., fig. 178 (1881);—French, Rep. Ins. Ill., vii: 161 (1878); Butt. east. U. S., 348-349 (1886);—Fern., Butt. Me., 103-104 (1884);—Mayn., Butt. N. Engl., 57-58, pl. 6, figs. 86, 86a (1886).
Papilio—Abb., Draw. Ins. Geo. Br. Mus. vi: 83, figs. 121-3 (ca. 1890).
 Figured also by Glover, Ill. N. A. Lep., pl. II, fig. 1; pl. K, figs. 7, 10, lect.

Gay knots of butterflies with pulsing wings,
 That scatter at the lone wayfarer's feet.

Midsommer noon.

Twine ye in an airy round,
 Brush the dew and print the lea;
 Skip and gambol, hop and bound.

DRAKE.—The Culprit Fay.

Imago (10:4). Head covered above with nearly uniform blackish brown hairs, below with a few whitish scales mingled with them. Palpi blackish, chocolate brown, hoary on the basal half beneath by an intermingling of white scales, which increase in abundance toward the base, and a few of which continue even to the extremity of the middle joint, accompanied by a few reddish scales; apical joint uniform blackish. Antennae black, narrowly annulated at the base of each joint with white, which, at the middle of the under surface, extends over nearly or quite the whole of each joint, and on the basal half of the club widens and forms a continuous patch tinged with yellow; excepting at the extreme base the upper surface of the club is wholly black; a few whitish scales are scattered over the distal half of the under surface; the crook is naked and castaneous, but nearly as dark as the club. Tongue piceo-testaceous, testaceous at tip, the papillae (61:57) consisting of only half a dozen, very distant, minute prominences set in depressions on the outer edge of either maxilla.

Thorax covered above with blackish brown scales and hairs, the latter becoming tinged with dull tawny at the hinder extremity; beneath covered with dark reddish brown hairs, mingled with silvery white hairs, especially on the coxae; legs blackish brown, with a maroon tinge, profusely flecked with mostly independent, silvery white scales, most abundant on the femora, which are fringed below with white and black hairs, the former preponderating; beyond the femora the pale scales become tinged with dirty yellow, or yellowish brown, to a greater or less extent, and on the tarsi are most abundant at the base of each joint, and generally absent from the apex of the same as well as from that of the tibiae; spurs dark brown, largely flecked with silvery white, often wholly white; spines reddish; claws dull luteous.

Wings above rich dark brown. Fore wings with the superior subcostal nervules tipped with white. The lowest three subcostal interspaces have each a small, white, generally longitudinal, dull white spot, forming a series in the middle of the outer half of the wing, nearly at right angles to the costal margin, but generally a very little arcuate, the convexity inward and tapering as it recedes from the margin; in the middle of the

basal half of the upper median interspace is an inconspicuous, minute, pale spot, occasionally accompanied by two other fainter ones following it in the interspaces above in the direction of the apex of the wing. The outer half of the wing is often flushed with a warmer tint by the presence of sparsely scattered, dull tawny scales. Fringe very pale tawny, tipped with white at the apex, along the whole base overlaid with a basal border of blackish brown, which extends around to the last of the nervules which impinges on the costal border, and interrupted rather broadly, distinctly and abruptly with the same at the nervule tips. *Hind wings* without markings, but with a few scattered, dull tawny scales on the outer half, and the nervules of the lower half accompanied by long tawny hairs. Fringe in general as on the fore wings.

Beneath blackish brown. *Fore wings* with the inner border much paler and all the markings of the upper surface exactly repeated; in addition, the outer margin is bordered with a broad, honry field, made up of a regular sprinkling of very pale blue, longitudinal scales; this cloudy field is generally broadest at the lowest subcostal nervule, where it is fully equal to the width of two interspaces, and has ill-defined limits, its inner border forming a curve which strikes the costal margin above just before the apex and reaches the tip of the submedian nervure below. Fringe as above, excepting that the pale color is frequently obscured in a greater or less degree. *Hind wings* wholly clouded with a rather profuse sprinkling of very pale bluish, longitudinal scales, thickest upon the outer third or two-fifths of the wing, and especially below, the distinction between this portion and that of the base being accentuated by a not very distinct, narrow, zigzag, transverse, bent, broken stripe, in which the pale scales are absent and which is sometimes accompanied externally by small, indistinct, dull yellow spots; its general direction is from the middle of the submedian nervure to the upper median nervule at the middle of the outer two-thirds of the wing, where it is bent and passes upward to just beyond the middle of the costal nervure; the middle of the basal half of the wing is covered with not very long white hairs. Fringe as above.

Abdomen very dark brown, enlivened above by scattered tawny scales, beneath profusely flecked with white and very pale bluish scales, particularly at the extremity of the segments. Upper organ of male appendages (37:3), with the two halves of the hook depressed, inclined slightly inward, a little longer than broad, outer angle rounded, inner square; points of the lateral arms clearly distinct from the hook, one below each half. Clasps with the upper margin a little sinuous, at the base broadly arched, the tip with a slight recurved tooth.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 11.75 mm.						
Length of fore wing.....	11.5	11.9	12.	11.2	12.	12.85
antennae.....	6.1	6.2	6.4		6.25	6.45
hind tibiae and tarsi.....	4.9	5.2	5.5	4.25	5.25	5.
fore tibiae and tarsi.....	3.4	3.5	3.6	3.25	3.5	3.6

Described from 31 specimens, of which 18 ♂, 13 ♀.

Egg (66:17). Surface delicately shagreened, the punctuations numbering about twenty to a cell, very minute, inconspicuous, circular. Cells near the base of the egg hexagonal, with two opposite sides longer than the others, and measuring .021 mm. by .0085 mm. Micropyle (69:7) consisting of an irregular cluster of kite-shaped cells around a common centre, having as a mass a diameter of .027 mm., and containing, in the incisures of same, pores opening into oblique canals, to the number of five or six, irregularly arranged but clustered toward the centre and occupying a field .0115 mm. in diameter; outside of this the cells are free of punctures over a space about .06 mm. in diameter. Color of egg, pale green. Height, .56 mm.: breadth, .9 mm.

Caterpillar. *First stage.* Head (80:46, 53) uniform, completely piceous, not quite smooth, minute papillae, bearing short, fine, colorless hairs, breaking the surface at rare intervals; ocelli black, in a black field, and therefore entirely inconspicuous; mouth parts blackish ferruginous. Body livid white at birth, afterwards becoming pale grass green, paler beneath; first thoracic segment with a piceous dorsal shield;

the pseudostigmatic blister on the middle of the sides of the other thoracic segments pale greenish testaceous; the long recurved hairs of the last segment black, accompanied by a few backward curving hairs along the edge of the anal plate, less than half as long; legs and prolegs the color of the body; claws of the former testaceous; spiracles scarcely distinguishable from the color of the body, barely testaceous. Length of body, 2.5 mm. when born; 4 mm. when full grown; breadth, .3 mm. to .45 mm.; height of head, .6 mm.; length of dermal appendages, .065 mm.; of the recurved hairs of the last abdominal segment, about .3 mm.

Second stage. Head (80:47) as broad as the broadest part of the body, rich bronze brown, faintly marked with the scattered hair insertions. Body pale green, with the piceous thoracic shield as before, distinctly traversed by the transverse creases of each segment; the numerous hairs simple, short, very delicate, blackish (excepting along stigmatal line, where they are pale), and seated on shining green warts of minute size and scarcely any elevation. Hairs of last segment not much longer than the others and not recurved. Beneath paler green, the legs and prolegs the same, the claws of the former fuscous, except the front pair, which are black in front. Spiracles luteous. Length, 6 mm.; breadth, .7 mm.

Third stage (80:48) blackish brown, sometimes strongly tinged with castaneous; labrum and mouth parts castaneous; the surface slightly rugose, by raised lines forming minute polygonal cells (i. e., honeycombed with fine raised lines) and studded with short white pile. Body very slender, as broad in middle as the head, pale green with a livid tinge; a dark green dorsal line; the whole upper surface frosted by short white pile, gradually increasing to tolerably long hairs on the last two segments. They are absent, however, from the first thoracic segment, which is livid, with a narrow posterior, transverse, equal, black shield, extending down nearly to the stigmata, broken just before the extremity so as to leave an independent round spot; an indistinct, slender, pallid, stigmatal line on the abdominal segments; under surface paler green, legs and prolegs concolorous; the front pair of legs and the others to a less extent infuscated, the claws blackish testaceous; stigmata pallid, with a luteous ring. Length, 9 mm.; breadth of body, 1 mm.; of head, 1 mm.

Fourth stage. Head (80:49) blackish brown, with a large, broad, vertical, pale band each side of the triangle, extending from the base half way to the top of the triangle, and a narrow, vertical pale band on the sides of the front above, and fading out below; besides the posterior edges of the head and ocelli the same pale color; all of this, however, evident only at first, for the head is apparently wholly bespangled with conical but very irregular, minute, snow-white tubercles, each giving rise to a short white hair, giving the head the same flocculent appearance as the body, but this does not appear directly after moulting, since the apparent tubercles are only flocculent gatherings at the base of the hairs. Body slender, equal, as broad in middle as the head, somewhat flattened, very pale green, with slender, brighter green, dorsal line, and on the abdominal segments a similar but more obscure laterostigmatal line, all nearly obscured by the heavy covering of snow-white, flocculent pile, giving the entire body a frosted appearance, each hair being a very irregular, inverted cone or prickly subglobular club, supported on a short and slender stalk; this flocculence does not surround the hair when it first assumes this stage. Length, 13.5 mm.; breadth of body, 1.8 mm.; of head, 1.3 mm.

Last stage (77:24). Head (80:50) deeply and densely, but very delicately rugose and covered with short and most delicate white, but not flocculent, tapering and pointed hairs. It is of a rather dull frosted white color, with vertical stripes of ferruginous, namely: a broad, lateral, vertical stripe, running from the anterior ocelli to the vertex, narrowing above and strongly tinged with brown; a broad and equal, vertical, median stripe from the summit of the triangle to and over the top of the head, narrowly divided by the pale suture; a narrow, vertical, median stripe in the triangle itself; and on either side of the triangle, and resting upon the narrow and smooth white band which surrounds it, a narrow, vertical stripe, extending from the base of the triangle to half way between its summit and the crown of the head and narrowly separated from the

upper vertical median stripe; suture of triangle black. Besides this the collar of the head, and the under surface are blackish brown. Antennae pale at base, testaceous beyond, including the bristle. Oral spine reddish testaceous; ocelli black; labrum pale; mandibles testaceous, the cutting surface blackish.

Body pallid green, the first segment with the linear, transverse, broken, dorsal shield black and the last segment less pallid, and fringed with some rather long, curving, tapering, colorless hairs, the whole body profusely dotted with pale green dots at the base of the excessively delicate and short, simple pile; spiracles pallid; legs and prolegs pale green, the former with testaceous claws.

This description was taken soon after moulting. It afterward has the same white powdered appearance, including the head, but before this gathers the skin is so transparent that all the organs of the body can be seen, the threads of some of the vessels waving continuously up and down the sides of the body. Length when full grown, 26 mm.; breadth of head, 1.8 mm.; of body, 2 mm.

Chrysalis (85:40). Delicate green, deepest in color on the basal half of the abdomen, tinged with livid luteous about the head and cremaster. Front of head, excepting ocellar ribbon, rather sparsely beset with parti-colored, more or less tawny, rather long, curving bristles; frontal incisures dusky. Prothorax with a few scattered, short, curving, blackish bristles on the anterior half. Thoracic spiracle testaceous. Dorsum of thorax with scattered, erect bristles like those on prothorax, more abundant and longer centrally than laterally. All appendages very pale green, excepting the tongue beyond the wing tips, where it is faintly tinged with luteous. Abdominal segments covered very sparsely with short, slightly curved, pale tipped, black hairs, directed backward. Cremaster very pale luteous, edged with tawny, the hooks tawny. Spiracles pale luteous, elongate, obovate. Length of body, 13.75 mm.; greatest breadth, 3.75 mm., length of cremastral hooks, .25 mm.

Distribution (29:6). This butterfly, a characteristic member of the Alleghanian fauna, has a wide distribution, much wider, doubtless, than our present knowledge shows; for besides being found distributed over a wide area of the country in the east, extending in the northern part of its range more than halfway across the continent, it has also been discovered on the Pacific coast and far south in Texas and Florida. Its northern boundaries may be indicated by the following, passing from east westward; Montreal, rare (Lyman), Ottawa, not uncommon (Fletcher); London, Ont. (Saunders), Sudbury and Nipigon, north of Lake Superior (Fletcher), Illinois (Worthington), Lake Winnipeg (Edwards), Fort Ellis, Manitoba (Geddes), Dakota and Montana (Edwards). Besides these it has been found as far west as Davenport, Io. (Putnam), and Illinois (Worthington). Its southern limits in eastern America are only indicated by a few localities such as Cincinnati, Ohio, rare (Dury), Cumberland Gap, Ky. (Dimmock), West Virginia (Edwards), Georgia, not very common (Abbot); but I have also seen specimens from Dallas, Texas (Boll), Appalachicola, Fla., not indicated on the map (Chapman), and California (H. Edwards).

It has been found throughout almost the whole of New England, though far more abundant in the southern than in the northern half, but in the north it occurs at Hallowell, Me. (Miss Wadsworth), and in the White Mountains (Morrison, Scudder). It has also been found in other

hilly parts of New Hampshire and Massachusetts, as at Milford in the former state (Whitney) and in the latter at Amherst where it is common (Parker, Morrison) and Mount Toby (Sprague); probably, therefore, it will be found throughout the southern half of the state in proper localities, for it has been taken at Springfield (Emery, Dimmock) and about Boston (Minot, Faxon) and is common enough in Connecticut (Norton, Scudder, Smith, Verrill).

Oviposition. The eggs of this butterfly are laid freely on grass; some laid on the 5th and 6th of June emerged on the 16th and 17th; others laid by the same female on the 9th and 10th were bitten at the top by the enclosed caterpillar on the 20th and most of them emerged by the 21st, the remainder on the following day.

Habits of caterpillar. The caterpillar feeds readily on common grass. Eggs were laid for Mr. Fletcher and myself on *Avena striata* and the caterpillars were partly raised by him on *Poa pratensis*. On emerging from the egg they eat the whole or nearly the whole of their forsaken shell. "As soon as they were placed on a tuft of *Poa pratensis* they crawled up to the tip of a blade and made a tent by drawing the opposite sides half way together with one strong strand of silk. Here they remained about five days, eating a little from the edge of the leaf" (Fletcher). A little later, and during its first and second larval stages it fastens together the opposite edges of a blade of grass by about a dozen strands of silk, tightening them gradually until a sort of tube is formed and it becomes difficult to see within through the crack. Later in life, and especially when about to change its skin and desiring greater concealment, it constructs a nest by doubling a leaf back upon itself and sewing the sides together, or by stitching together three or four contiguous blades into a tube, lining the floor with a dense coating of silk. When more than half grown it not infrequently comes out of its nest, when the flocculent covering has fairly developed, and rests stretched at full length on a blade of grass, its head thrown back so that the face is dorsal. In no other Hesperian have I seen any such tendency to exposure, which Mr. de Nicéville tells me is constant in the Indian *Gangara thyrsis* in which the flocculence is extremely developed. Mr. Fletcher, as already stated, has since noted the same thing in *Pamphila mandan*. Our caterpillar seems excessively delicate; its skin apart from the flocculence permits all the internal organs to be seen and, especially in the latter part of its life, it is exceedingly sluggish and wanting in spirit. Its development is slow. The eggs, as we have seen, hatch in from eight to eleven days, the first stage lasts only three or four days, but the succeeding stages much longer, so that it is at least a month after this, sometimes five weeks, before the caterpillar has stopped feeding; it is then about ten days before the change to chrysalis takes place; this lasts about thirteen days, so that from egg laying to butterfly requires about seventy days.

Pupation. When the largest caterpillar began to grow uneasy, to wander and refuse to eat, it was placed in a vessel with a bunch of fresh and old grass, in which, after resting for a day on the side of the vessel, it finally made a very slight cocoon by fastening the edges of two or three adjoining blades, bringing these close together at the two ends and lining the whole very thinly, indeed, but very completely with silk, which in the cracks between the grass blades showed many minute openings under the lens, and presented a reticulated appearance. Here, after resting about six days, the chrysalis change occurred, apparently without any cross strands of silk whatever for the body or cremaster; the cremaster was plunged into the silk on one side of the nest, but so slightly that on opening the cocoon at the head end, the chrysalis slipped out. The silk had a white and flocculent appearance, much like the larva before its change of skin. In about eight days a pallor began to arise about the wings, followed the succeeding day by a decided discoloration of the back of the thorax and of the appendages; two days later it had turned inky black throughout, and the following day the imago emerged, the chrysalis period being about thirteen days. This was at Cambridge where the insect had been reared from eggs laid in the White Mountains.

Life history. In the north it is single brooded and apparently passes the winter as a chrysalis, since the butterflies make their appearance in the latter part of May, generally from the 21st to the 25th, though their appearance is sometimes delayed until the first of June; the female certainly appears almost as soon as the male, and specimens continue to emerge from the chrysalis up to the 10th of June, judging from the condition of specimens captured at large. It often flies until the end of June, sometimes until the close of the first week in July; but unfavorable weather may put an end to the brood by the middle of June. The eggs are laid at least as early as the 5th of June and hatch in about eight or nine days. Further south there must be at least two broods, to judge simply from two facts; first, that the butterfly was taken in Georgia by Abbot on April 27, and second that caterpillars, hatched in the White Mountains in the middle of June and carried to Boston, changed to chrysalis before the end of July, and from the chrysalis the butterfly emerged on the 11th of August. But inasmuch as no second brood of this butterfly has been found in the White Mountains in the latter part of the season, it is plain that this result was reached by carrying the caterpillar to so southern a locality, and indicates that in so southern a point in its range as Georgia, a second brood is a regular occurrence, if indeed there be not a third.

Behavior of the butterfly. It flies in meadows and by the roadside flowers like the rest of this group of Hesperidae, although Abbot, as usual, records its capture in "oak woods," the best collecting ground in the south.

When at rest, the fore wings diverge at an angle of from 20° to 25° , the inner margin resting on the upper surface of the more expanded hind wings, which diverge at an angle of about 120° ; the antennae, viewed from above, spread at an angle of from 120° to 130° , and are perfectly straight; viewed laterally, they are on a line with the plane of the body, which itself is elevated anteriorly about 30° above the surface of rest; the tip of the club is bent at right angles backward. When feeding on a flower it rests with all its wings raised perpendicularly but not closed. It has the habit, when at rest, of giving its antennae, each independently, a sort of circular motion, mainly from above, downward and forward, and reversely.

Desiderata. The geographical distribution of this butterfly is still insufficiently known; especially should the inland states of the Alleghanian fauna and the central parts of New England be searched for localities. It is plain that its range is much more extended than we know, for a glance at our map shows it. Although all the early stages are known, our information regarding its periods are at fault and some of the data conflicting. Has any one ever captured a specimen of a second brood in the open country? Observation of the natural habits of the caterpillar out of doors is desirable to explain the exceptional flocculence of the body, and the caterpillar's custom of partially open life. Since its postures show some interesting affinities to those of *Ancyloxipha*, a description of its peculiarities of flight is more than usually desirable; no parasites are known.

LIST OF ILLUSTRATIONS.—*AMBLYSCHIRTES VIALIS.*

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| <p><i>General.</i></p> <p>Pl. 29, fig. 6. Distribution in North America.</p> <p><i>Egg.</i></p> <p>Pl. 66, fig. 17. Outline.</p> <p>14 60:7. Micropyle.</p> <p><i>Caterpillar.</i></p> <p>Pl. 77, fig. 24. Mature caterpillar.</p> <p>80: 46-50. Front views of head, in all the stages.</p> <p>53. Head of caterpillar in egg as seen through the egg shell.</p> | <p><i>Chrysalis.</i></p> <p>Pl. 85, fig. 40. Chrysalis.</p> <p><i>Imago.</i></p> <p>Pl. 10, fig. 4. Male, both surfaces.</p> <p>37: 3. Male abdominal appendages.</p> <p>42: 4. Neuration.</p> <p>68: 1. Side view of head and appendages enlarged, with details of the structure of the legs.</p> <p>61: 57. Extremity of tongue with papillae.</p> |
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AMBLYSCIRTES SAMOSET.—Pepper and salt.

[Little brown skipper (Abbot); yellow fringed brown skipper (Maynard).]

Hesperia samoset Scudd., Proc. Ess. inst., III: 176-177 (1863).*Amblyscirtes samoset* Scudd., Syst. rev. Am. butt., 54-55 (1872);—Fern., Butt. Me., 104 (1884);—French, Butt. east. U. S., 300-301 (1886);—Mayn., Butt. N. Engl., 58, pl. 7, figs. 87, 87a (1886).*Hesperia hegon* Scudd., Proc. Ess. inst., III: 176 (1863).*Hesperia nemoris* Edw., Proc. entom.

soc. Philad., II: 507 (1864); Trans. Amer. entom. soc., 1: 288 (1867).

Hesperia alternata Grote-Robl., Trans. Amer. entom. soc., 1: 3-4 (1867).*Papilio* ——— Abb., Draw. Ins. Geo. Br. Mus., VI: 81, figs. 117-118; xvi: 58, pl. 85 (ca. 1800).

Figured by Abbot, Draw. Ins. Ga., Oemler coll., Bost. soc. nat. hist., 12;—Glover, Ill. N. A. Lep., pl. 29, fig. 6; pl. G, fig. 97; pl. I, fig. 117, ined.

The butterfly and humble-bee
Come to the pleasant woods with me.TROWBRIDGE.—*Midsummer*.Down the glen, across the mountain,
O'er the yellow heath we roam.DARLEY.—*Song of the Summer Winds*.

Imago (10: 1, 3). Head covered above with pale yellowish green hairs and scales mingled with many blackish ones, all collected into parallel transverse patches more or less divided in the middle, in which the pale surround the dark scales and hairs; pencil of hairs outside the antennae black; beneath, the scales are white or pale yellow, deepening into lemon or buff yellow in a narrow belt behind the eye, which extends to the antennae. Palpi with the basal joint and extreme base of middle joint pale yellow; beyond clothed with nearly equally mingled pale yellow and black scales, the latter rather more profuse above than elsewhere; terminal joint black, yellow below exteriorly. Antennae black, interrupted on the basal half to third of each joint above with very pale nacreous yellow; below, the yellow extends over a greater space and especially interiorly where it is nearly continuous; on the lower inner side of the club it is continuous, forming a large patch; apical half of the club above velvety black without annulations; crook naked, castaneous.

Thorax covered above with mingled olivaceo-tawny and dark brown hairs, overlying dark purplish scales; below covered with pale dirty yellow hairs, mingled with a few black ones on the coxae. Legs very pale buff, heavily flecked with dark purplish brown on the upper surface of the tibiae and tarsi and on the sides of the femora; spurs very pale buff, spines and claws luteous, occasionally tinged with castaneous.

Wings above rich dark brown. *Fore wings* with a transverse, straight or nearly straight series of three very pale straw yellow or whitish longitudinal dashes ordinarily less than twice as long as broad in the lowest three subcostal interspaces, the middle one occasionally slightly removed toward the base of the wing; the series lies at right angles to the costal margin, just beyond the middle of the outer half of the wing. Two spots of a similar color, but a little larger and quadrate, occupy the median interspaces, and an inconspicuous minute spot or a mere dot the lower interspace beyond the cell, all in a straight line running from the middle of the inner border to the uppermost dark bar in the fringe of the outer border; traversing the cell just above the second divarication of the median nervule is a pair of similar, minute, longitudinal spots, the upper a little further removed from the base than the lower, scarcely more conspicuous than the uppermost median spot; within the outer series of spots the wing is rather abundantly sprinkled with longitudinal, greenish yellow scales, especially along the costal border, often even to the tip of the wing, on the basal half of the cell, along the edge of the inner border and in the lower median and medio-submedian interspaces as far as the second divarication of the median nervule; fringe

whitish straw yellow, overlaid at the extreme base with dark brown and abruptly and conspicuously though rather narrowly interrupted with the same at the nervule tips. *Hind wings* uniform, rarely with a vague, ill-defined, pale, narrow arc, parallel to the outer border, in the middle of the outer two-thirds of the wing, reaching neither border; the basal two-thirds of the wing usually flecked lightly with pale scales and the nervures of the lower half of the wing fringed with long, pale greenish yellow hairs. Fringe very pale straw yellow, the extreme base overlaid with dark brown, and beyond inconspicuously interrupted at the tips of the nervules of the middle of the wing with dark brown, which seldom reaches the outer limits of the fringe.

Beneath of the same brown as above, but, excepting on the lower half of the fore wing, uniformly and profusely flecked with very pale greenish yellow scales, giving the wing a greenish gray appearance. *Fore wings* with the limitation of the flecked and brown portion of the wing following the median nervure and the third median nervule as far as the middle of the latter and then curving to the extremity of the lower median nervule, the pale scales following the nervures slightly; the spots of the upper surface are repeated beneath, the smaller ones occasionally obliterated, the others usually larger, but, excepting in the unflecked portion of the wing, no more conspicuous. Fringe as above. *Hind wings* with a moderately small, pale yellow spot in the middle of the basal two-thirds of the costo-subcostal interspace, a similar one in the lower half of the outer two-thirds of the cell and a curving, bent, moderately narrow series of partially connected, similar spots more or less tinged with greenish in the middle of the outer two-thirds of the wing, commencing with a spot usually almost independent in the middle of the apical two-thirds of the costo-subcostal interspace, bent at the lower subcostal nervule and terminating in the upper half of the medio-submedian interspace just below the middle of the lowest median nervule; it varies in width in different individuals and when very narrow may be obsolete above the middle of the subcosto-median interspace, excepting the uppermost spot. Fringe as above.

Abdomen dark brown, the sides and under surface heavily flecked with long, pale olivaceous hairs and scales, beneath also annulate with pale greenish yellow at the ends of the joints. Centrum of upper organ of male abdominal appendages (37:4) with a strongly compressed and elevated, median, longitudinal lamina upon the summit, the two halves of the hook scarcely separate, either from one another or the lateral arms, with which they form a blunt conical prominence directed backward. Clasps with the upper margin nearly straight, the base scarcely arched, the tip with a very small, pointed tooth, scarcely recurved.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	11.6	12.2	12.3	11.5	12.1	12.5
antennae.....	6.25	6.75	6.75	6.35	6.65	7.
hind tibiae and tarsi....	5.	5.75	5.75	5.	5.	5.2
fore tibiae and tarsi....	3.9	3.95	3.95	3.5	3.5	3.6

Described from 9 specimens, of which 3♂, 3♀.

Caterpillar. *Last stage* (77:29). Head pale, the sutures and eye-spots marked with reddish. Body very pale green, the first thoracic segment with a rather slender and short, black, dorsal shield; a slender dorsal stripe of rather darker green, slightly deeper again in tint below the spiracles. Length, 23.25 mm.; height, 4 mm. Described from Abbot's drawings.

Chrysalis (85:45). Dull straw yellow, paler on the sides of the abdomen, tinged with green, especially on the wings. Tongue, at least where it extends beyond the body, dull orange. Length, 11 mm.; height, 4 mm. Tongue tip beyond the wing tip, 4.75 mm. Described from Abbot's drawing.

Distribution (29:7). Although apparently nowhere abundant, this butterfly occurs in scattered localities throughout much of the Alleghanian

fauna and even extends beyond its limits; Edwards finds it in West Virginia (not noted on the map) and Abbot and Grote and Robinson report it from Georgia, where the former says it "is not common"; probably it follows down the Appalachians; westward it extends to Michigan (Strecker), Illinois and Iowa (Allen) and Wisconsin, numerous (Hoy), while across the line it has been found in Ontario (Edwards) and Nova Scotia (Bethune).

In New England it is found in such northern and elevated localities as Norway, Me. (Smith) and the White Mountains of New Hampshire (Seudder, Morrison) which give us reason to look for it throughout the Canadian fauna. The only other New England localities in which it has been taken are Milford, N.H. "rare" (Whitney) and several localities in Massachusetts—Amherst (Peabody), Springfield (Dimmock, Morrison), Belmont and Milford (Morrison).

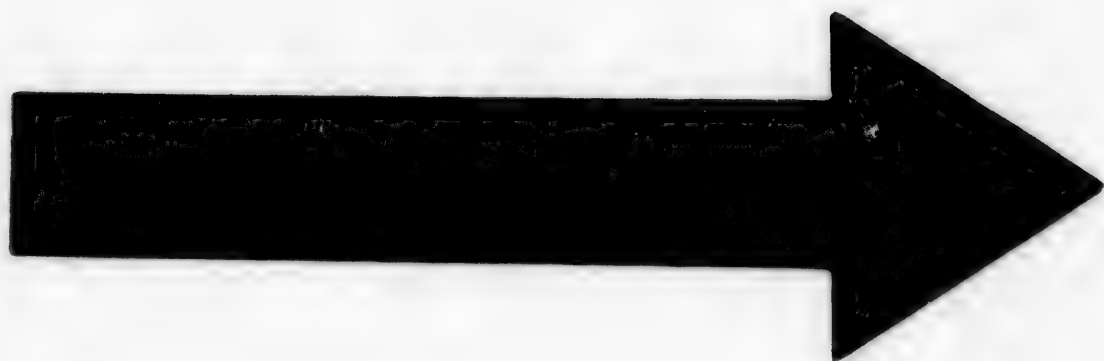
Food plant of caterpillar. According to Abbot, the caterpillar feeds upon "wild oats"; the plant given by Abbot in the British Museum drawings is there recorded as *Andropogon avenaceum* (*Sorghum avenaceum*). In the Boisduval MS. it is given as *Sorghum secundum*.

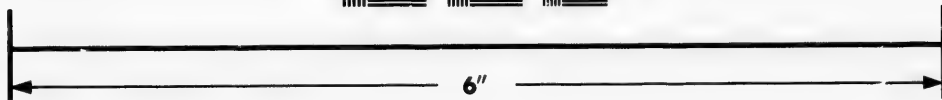
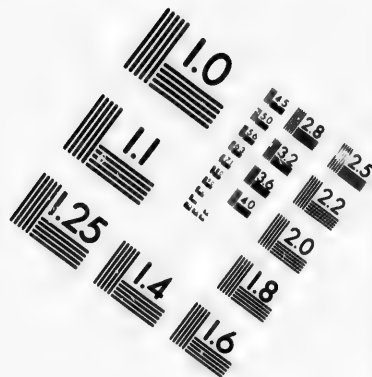
Life history and habits. It appears to be single brooded in the north and double brooded in the south, probably passing the winter in each case in the chrysalis state. The only preserved memoranda of Abbot's state that a caterpillar made its cocoon May 31 and the butterfly appeared June 14, and that a specimen was captured on August 8; probably—judging by analogy with its congener—these latter dates refer to butterflies of the second brood. The duration of the chrysalis in the summer is then less than a fortnight. The first brood, according to Edwards, appears in West Virginia early in April. The single brood of the northern states appears in the imago state early in June and continues through July. About Boston it first appears at the very beginning of June, but at the White Mountains it rarely appears much before the seventh and is most abundant about the middle of the month.

Edwards, speaking of *Cyaniris pseudargiolus violacea* says (Butt. N. A., i):—

By the 3d or 4th of April we usually have one or two very warm days, the mercury at 80°, and then these little butterflies swarm along the sunny sides of the creeks, gathering in clusters as close as they can stand, in favorite spots, motionless, with wings erect and closed, wholly intent on extracting from the sand some fluid, no doubt delightful. With them will often be seen some of the smaller Hesperians, especially that sturdy little fellow, *H. samoset* Scudd., who has placed himself like a sentinel outside the throng, with wings half open and suspicious antennae, ready to dart away for the least cause, frightening for a moment his busy associates. He will not return till the danger is past, but they, after fluttering about a little, settle down as before.

The butterfly appears to frequent open places in woods; in the Glen at the White Mountains it is found only in forest roads. In Iowa and Illi-





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nois, Mr. Allen took it in an open grove and a timbered ravine; and Mr. Abbot says it "frequents the oak woods" in Georgia.

Desiderata. The rarity of this butterfly tempts one to enquire into its cause; especially as the insect belongs to a group which usually abounds in individuals. Its somewhat anomalous distribution should be explained. Its annual history has been meagrely sketched from insufficient data and requires both verification and extension. Where between West Virginia and New England does it occur and where does it change from a single to two broods a season? Nothing is known of the earlier stages but what may be gleaned from Abbot: its parasites and the flight and postures of the butterfly are quite unknown.

LIST OF ILLUSTRATIONS.—*AMBLYSCIRTES SAMOSET.*

- | | | | |
|--|---------------------|--|-------------------------|
| <i>General.</i> | | <i>Imago.</i> | |
| Pl. 29, fig. 7. Distribution in North America. | | Pl. 10, fig. 1. Female, both surfaces. | |
| | <i>Caterpillar.</i> | | 8. Male, both surfaces. |
| Pl. 77, fig. 29. Mature caterpillar. | | 37:4. Male abdominal appendages. | |
| | <i>Chrysalis.</i> | | |
| Pl. 85, fig. 45. Chrysalis. | | | |

SECTION II.

Egg not so low as in the preceding section, the height usually more than two-thirds the breadth, never ribbed. *Caterpillar at birth* with relatively long bristles on the terminal abdominal segments, usually at least as long as the breadth of the head. *Mature caterpillar* with a rounded head not any higher than broad, if as high, held only vertically. *Chrysalis* not infrequently unimucronate in front. *Imago* with the antennal club always with a distinct, often a very long hook, the abdomen rarely surpassing the hind wings, always tolerably stout; fore tibial epiphysis and middle pair of hind tibial spurs always present; a discal stigma generally found on the fore wings of the male; lateral arms of upper organ of male abdominal appendages free through at least much of their course.

GENERA: *Poanes*, *Phycanassa*, *Atrytone*, *Hylephila*, *Erynnis*, *Atalopedes*, *Anthomaster*, *Polites*, *Thymelicus*, *Limochores*, *Euphyes*, *Calpododes*, *Oligoria*, *Lerema*.

POANES SCUDDER.

*Poanes** Scudd., Syst. rev. Amer. butt., 55 *Hesperia* pars Auctorum.
(1872). *Pamphila* pars Auctorum.

Type.—*Hesperia massasoit* Scudd.

Ne (may it be withouten perill spoken)
The Archer god, the sonne of Cytheree,
That joyes on wretched lovers to be wroken,
And heaped spoyles of bleeding harts to see,
Beares in his wings so manie a changefull token.
Ah! my liege Lord, forgive it unto mee,
If ought against thine honour I have tolde;
Yet sure those wings were fairer manifolde.

SPENSER.—*Mutopotmos*.

Imago (59:1). Head moderately large, covered with short scales and moderately long hairs, the latter arranged in transverse masses; outside the antennal base a rather slight, somewhat spreading, tuft of not very long, somewhat arcuate, bristly hairs, directed outward and scarcely reaching one-third way around the semicircumference

* *πόα*, *ποιός*, one who dwells in the grass.

of the eye. Front but little tumid, not much and equally surpassing the front of the eyes, more than twice as broad as long, separated from the vertex by a slightly arcuate, shallow sulcation, connecting the bases of the antennae in front of the middle, a little depressed in front of the antennae, the front margin slightly excised and slightly marginate, laterally considerably docked, the sides slightly convex and reaching the outer edge of the antennae. Vertex somewhat tumid by being arched longitudinally, but transversely nearly flat, excepting at the sides, half as long again as the front, elevated above the level of the eyes anteriorly, failing to reach it posteriorly, separated from the occiput by a pretty strongly bent, slightly impressed, transverse line; a transverse, arcuate, not strongly pronounced ridge crosses the middle of the vertex, opening backward. Eyes large, pretty full, nearly circular, naked. Antennae inserted near the front of the summit, their interior edges separated by a space three times as great as the width of the basal joints; a little shorter than the abdomen, composed of forty joints, of which twenty-three form the club, which is contained about one and three-fourths times in the stalk and is bent beyond the middle of the apical two-thirds; the portion before the crook increases regularly in size for its basal three-fifths, and then remains of nearly the same breadth—more than equal to the length of two joints—until just before the crook, which consists of about a dozen joints and tapers rapidly and regularly to a point; the joints of the middle of the stalk are nearly two and a half times longer than broad. Palpi pretty stout, nearly twice as long as the eye, the basal joints heavily clothed with long scales, beyond which nearly the whole of the apical joint projects, clothed only with recumbent scales; basal joint nearly globular, produced a little anteriorly, broader than long and less than one-third the length of the middle joint; middle joint large, tumid, straight, cylindrical, well-rounded at base, subconical toward tip, fully two and one-half times as long as broad, of the same breadth as the basal joint; apical joint minute, slender, cylindrical, tapering slightly, in length equaling the breadth of the middle joint, and four times as long as broad, the tip bluntly pointed.

Prothoracic lobes pretty large, appressed, laminate; when viewed from the front, rounded subtriangular, half as long again as high, nearly as long as the shorter diameter of the eye. Patagia large, the posterior lobe nearly half as broad as the base and as long as it, tapering slightly, the tip rounded off, the whole piece considerably shorter than the breadth of the head.

Fore wing (42.5) two-thirds as long again as broad; the lower outer angle falling somewhat before the apical third of the costal margin; costal margin gently convex at base, beyond nearly straight; outer margin gently and pretty regularly convex; inner margin very slightly concave in the apical half. Costal nervure terminating a little beyond the middle of the costal margin; subcostal nervure moderately distant from the costal margin, the second nervule arising at the middle of the wing; cell a little more than three-fifths the length of the wing, of nearly equal width in the distal half; the second median nervule arising a little further from the base than the second subcostal nervule; the first median at one-third the distance from the second median to the base; internal nervure short, straight.

Hind wing hardly a fifth longer than broad, well rounded; the costal region strongly lobed at the base, gently convex beyond; the outer margin well rounded, fullest in the lowest subcostal region; the anal angle subangulate. First subcostal and median nervules arising at equal distances from the base; the second median nervule about halfway between the base and the margin.

Legs 2, 3, 1; femora clothed as in *Erynnis*; tibiae furnished above with distant, short, delicate spines, those of fore tibiae inconspicuous. Femora 2, 1, 3; tibiae 2, 3, 1; tarsi 2, 3, 1. Fore femora slightly longer than the hind pair and three-fourths the length of the middle pair. Fore tibiae less than two-thirds the length of the fore femora, scarcely more than half as long as the middle tibiae, which are scarcely longer than the hind pair. Leaf-like appendage of fore tibiae long and slender, originating on the middle of the apical four-fifths of the joint, surpassing it a little, tapering to a point on the apical third, a little arcuate, about five times as

long as broad; the other tibiae furnished at tip with a pair of very long and slender spurs, the hind tibiae also with an exactly similar pair in the middle of the outer two-thirds. Tarsal joints 1, 2, 3, 4, 5, excepting in the fore legs, where the apical joint is distinctly longer than the penultimate. Fore tarsi longer than the middle tibiae, four-fifths the length of the middle and hind tarsi, all with a triple row of not very long, delicate spines, the apical ones of each joint slightly longer than the others; basal joint as long as the rest together; second joint half as long as the first. Claws very small and delicate, tapering very regularly to a fine point, pretty strongly and regularly arcuate. Pad moderate, tumid; paronychial bilobed, the upper lobe lateral, laminate, straight, regular, tapering to a blunt point, reaching to the tip of the claw, nearly twice as long as broad; the inferior lobe originating as low as possible, slender, equal, threadlike, fringed beneath, half as long as the claw, and straight.

Upper organ of male abdominal appendages of medium size, reaching as far as the clasps, arched pretty strongly at base, but beyond straight, depressed, rather narrow, hook double, consisting of two very slender, equal, not very long, parallel, widely separated fingers; lateral arms consisting of a broad, depressed, equal plate, stretching a little beyond the hook and close to it. Clasps very broad, basal half equal, but little convex, beyond curving upwards to a fine but not greatly produced point; middle of upper edge with a rounded lobe.

This genus consists of but a single species, whose distribution in eastern North America is given below.

The perfect insect is of small size, with dark mulberry colored wings, the upper surface of the female and the under surface of the fore wings of both sexes with an interrupted extra-mesial band of pale spots, few in number, the under surface of the hind wings with a very large, central, yellow spot, consisting of two bands crossing each other—one arcuate and transverse, the other straight and longitudinal.

Nothing is known of the history of this butterfly excepting that it is double brooded.

EXCURSUS LXIII.—BUTTERFLIES AS BOTANISTS.

And evermore with most varietal,
And change of sweetness, (for all change is sweet),
He casts his glutton sense to satisfy,
Now sucking of the sap of herbs most meet,
Or of the dew, which yet on them does lie,
Now in the same bathing his tender feet:
And then he percheth on some branch there by,
To weather him, and his moist wings to dry.

SPENCER.—*Mutopotmos*.

Two facts referred to in a recent excursus, as brought out from a study of the food plants of the caterpillars of butterflies, are more striking when brought into contrast: the narrow choice of very many species which feed upon a single species or genus of plants, and the very large number of families of plants which are brought under contribution to feed the entire body of our caterpillars. The fact that considerably more than half of the families of plants are sought by only a single family of butterflies and indeed usually by but a single species of butterfly is only what one who

has reared butterflies might expect, since he must often have found that under no consideration would a given caterpillar feed upon anything whatever but its own pet food plant. This is more striking because of the polyphagous nature of others, such as *Jasoniades glaucus*, which feeds upon plants belonging to no less than fifteen different families.

In many, perhaps the majority, of instances the plants upon which allied species or genera of caterpillars feed themselves, belong to allied families of the botanical systems; and Fritz Müller brings forward some curious instances in which a knowledge of the habits of butterflies would have led, had they been followed, to an earlier recognition of the affinities of certain plants. Thus he says (*Nature*, xxx: 240):—

“The caterpillars of *Mechanitis*, *Dircenna*, *Ceratinia* and *Ithomia* feed on different species of *Solanaceae* (*Solanum*, *Cyphomandra*, *Bassovia*, *Cestrum*), those of the allied genus *Thyridia* on *Brunfelsia*. Now this latter genus of plants had been placed unanimously among the *Scrophularineae*, till quite recently it was transferred by Bentham and Hooker to the *Solanaceae*. Thus it appears that butterflies had recognized the true affinity of *Brunfelsia* long before botanists did so.

“There is yet another and more curious instance of our butterflies confirming the arrangement of plants in Bentham and Hooker’s ‘*Genera plantarum*.’ *Ageronia* and *Didonis* were formerly widely separated by lepidopterists, being even considered as constituting distinct families, but now they are to be found beside one another among the *Nymphalinae*, and the structure of their caterpillars leaves no doubt about their close affinity. The caterpillars of *Ageronia* feed on *Dalechampia*, those of *Didonis* on *Tragia*. Now these two *Euphorbiaceous* genera were widely separated by Endlicher, who placed the former among the *Euphorbiceae*, the latter among the *Acalypheae*; Bentham and Hooker, on the contrary, place them close together in the same sub-tribe of *Plukenetieae*, and thus their close affinity which had been duly appreciated by butterflies has finally been recognized by botanists also.”

The narrow choice of certain species is perhaps indicated in our own fauna by what we know of the food plant of *Phyciodes tharos*. So far as we know it feeds only upon a single species of *Aster*; “and if your butterfly selects only that,” said the late Dr. Gray when I told him of this, “it is a better botanist than most of us.” Only one other plant has been alleged as its food and that probably by mistake. This special *Aster* the female selected out of many furnished it by Mr. Mead whereon to lay her eggs and no one has yet reared it upon any thing but *Aster novae-angliae*. Considering the difficulty that botanists have with the species of this group, such restriction of choice, if really true, certainly indicates some keen perception on the part of the butterfly.

Now with exceedingly rare exceptions the eggs of butterflies are laid

upon the very plant upon which the caterpillar will feed. In certain instances where the plants are abundant, as in the case of grasses, the butterfly may lay upon an object in the near vicinity and this, too, has happened in a few instances in the case of butterflies which are more particular in their choice. Thus, I once saw a European Satyrid lay an egg on a dead blade of grass lying loose upon the ground, have seen one of our species of *Brenthis* lay eggs upon grass in the vicinity of violet, and found the egg of a Pamphilid upon a thistle growing among grasses. These exceptions seem only to prove the general rule that the eggs of butterflies are laid directly upon the food plant of the young.

This is an act of instinct, one will say. But is this any explanation? We wish to know how the instinct acts. A parent butterfly that in its early life has been nourished upon willow, has no means in the winged condition of tasting the willow to recognize it. Werneburg, indeed, tries to argue that butterflies have no sense of taste because they often seek water, adding that meteoric water has no taste; but the water drunk by them is extracted from and lies upon the soil from which it will have gained some taste, and he strangely overlooks the fondness of many for ammoniacal waters and of all for the honeyed sweets of flowers. There can be no doubt indeed of their powers of taste, but it cannot be by this means that they recognize the plants upon which their young should feed, their organs of obtaining food being suited only for liquid nourishment.

Nor can it be by sight. It is true that butterflies are attracted by flowers through their means of vision. Interesting stories are told of their being deceived by painted or artificial flowers. But in these cases there is no reason to suppose that it is anything but the tint in mass that attracts them to the coveted spot. Pray how does the green of one plant differ from all others? Anatomy and experiment both teach us in the clearest way that butterflies have no power of vision sufficient for any such powers of distinction as are required of them in selecting special food plants for their young; which yet they discover in an unerring manner.

There remains apparently nothing but smell. That their sense of smell is acute is plain from facts coming from a quite different source, which have been collected in a previous excursus on Aromatic Butterflies. The production of odor implies the recognition of odor, and inasmuch as the organs through which the odor is known in many cases to be emitted exist in a very much larger number of butterflies than have been recognized as odorous, it would seem a warrantable conclusion that, though we cannot perceive their odor, they nevertheless produce odors recognizable by their mates. Now, we know in a similar way that many plants are odorous quite apart from their flowers; and if one, with this idea in mind, will but watch the movements of a mother butterfly seeking a spot whereon to lay her eggs, he will not fail to recognize that many of these

actions seem particularly in keeping with the notion that she is at work *scenting* the various plants that bear a general resemblance in their aspect to the plant which she seeks; many, indeed, which have no such general appearance, settling or half-settling in a dozen different places in the near vicinity of the plant, reaching it by nearer and nearer approaches and finally settling with satisfaction at the desired spot. To such an observer it will seem tolerably clear that it is to the sense of smell that butterflies owe their recognition of botanical species.

POANES MASSASOIT.—The mulberry wing.

[Yellow cross skipper (Maynard).]

Hesperia massasoit Scudd., Proc. Ess. Inst., figs. 80, 80a, b (1886).
Ill: 171 (1868).

Pamphila massasoit Kirb., Syn., cat. Lep.,

607 (1871);—French, Butt. east. U. S., 302
(1886);—Mayn., Butt. N. Engl., 68-69, pl. 7,

Poanes massasoit Scudd., Syst. rev. A. m.
butt., 55 (1872).

Figured by Glover, Ill. N. A. Lep., pl. 23,
fig. 1, ined.

The butterfly, gay-painted soon,
Explores awhile the tepid noon,
And fondly trusts its tender dyes
To tickle suns, and flattering skies.

WARTON.—*The first of April.*

Round Massasoit's head
A halo bright is shed;
Though dim the records are,
His glory, like a star,
Shines through history's night,
Transcendent, clear, and bright.

TAPPAN.—*Hesperia.*

Imago (10:6). Head tufted above with greenish yellow hairs, with intermingled black ones; eyes black; antennae above velvety black, with a purplish tinge, interrupted at the bases of the joints with ochreous; beneath ochreous, graduating into a sort of orange at the sides, slightly broken with blackish at the tips of the joints; club blackish brown above to the very tip; beneath the same, but the base greatly infringed on by the ochreous orange of the stalk; and the whole hook and three or four apical segments of the club proper fuscous orange. Palpi covered beneath with pale ochreous and dirty white scales, with a few intermingled longer black hairs; toward the tip and above, the scales become more decidedly ochrey, and, as well as on the inner side, are interrupted by a large number of blackish scales; terminal joint blackish brown, mostly concealed by the tufts of lower joints; tongue dull black, tipped with dark yellowish brown.

Thorax covered above with purplish brown scales, concealed by long, ochraceo-olivaceous hairs, the front and outer edges of patagia with shorter tawny ones, the prothoracic lobes with ochraceous-tipped, black, upright scales; beneath with intermingled light ochrey-yellow and blackish hairs, the former in greater profusion; femora blackish, fringed along lower edge with light ochrey yellow hairs, with a few intermingled black ones; tibiae and tarsi salmon brown, becoming gradually slightly infuscated toward the tip; spurs and spines of the same color, claws brownish fuscous.

Wings above nearly uniform, slightly lustrous brown black, male with a very slight mulberry tint, female with a more decided but not very brilliant dark violaceous tint; the centre of the basal two-thirds of each wing with blackish purple reflections, the base of the *fore wings* in the interspaces slightly, and the whole inner border three-fourths of the distance to the outer border, broadly and rather heavily fringed with tawny hairs; fore wings of the female with three short and small, broad, rounded,

whitish or straw-yellow dashes, increasing in size away from the costal border, situated between the terminal branches of the subcostal nervure, just below the termination of the second nervure, their inner edges at right angles to the costal border; also with two larger, similarly colored spots, the upper truncate, wedge-shaped, the lower subquadrate, in the lower median interspaces, not far from their base, the outer edge of the lower on a line with the inner edge of the upper; occasionally a few colored scales are seen in the discoidal cell a little within the lower of these two spots. *Hind wings* of female with a discal row of four yellowish orange, subquadrate, longitudinal spots, their borders obscured by a sprinkling of dusky scales, situated in the middle of the outer half of the wing, in a diagonal row in the median and subcosto-median interspaces, nearly at right angles to the inner border; a similar fifth spot occurs in the last subcostal interspace, the outer edge of the spot on a line with the inner edge of the previous spot; the fore wings of the male are usually immaculate, but occasionally the markings of the female are indicated by a few tawny scales; the hind wings are immaculate.

Beneath, *fore wings* slightly lustrous, dusky brown, the costal and outer border, especially near tip of wing, sometimes rather broadly bordered with dark reddish tawny, on the outer border cut across by dusky at the veins, and sometimes edged faintly with dusky. The markings of the upper surface of the female are generally repeated beneath in both sexes (sometimes enlarged) as yellowish orange or straw yellow spots, and there is sometimes an additional spot in the cell, directly over the one mentioned; the fringe is of the color of the outer border, a little more dusky at the tip. *Hind wings* with a very large central spot of bright straw yellow, occupying the whole of the space between the subcostal and median veins, from the base nearly to the border of the wing; occupying also the basal half of the median interspaces, except a minute portion at the very base and a longitudinal quadrate patch in the middle of the lower subcostal interspace; usually it also occupies, to a greater or less extent, a quadrate patch in the interspaces above and below this delimitation, but is frequently obscured to a greater or less degree by tawny scales; this common central spot is marked with fulvous or tawny at the extremity of the cell and where the nervures cross it; outside of this spot the wing is sometimes wholly blackish brown (in specimens having the fore wings nearly unicolorous), the outer margin with a few tawny scales sprinkled over it, especially on its lower half; but usually the costal border and the outer margin as far as the last median nervule are blackish, enlivened by a rather profuse sprinkling of tawny scales, especially along the outer border, and here particularly just next the border, which is marked by a dusky line; the inner border and lower portion of the outer border are also blackish beneath, but are so obscured by orange tawny and bright yellowish scales as to give them a grayish pale tawny appearance; fringe in general partaking of the color of the adjoining part of the wing, or a little lighter.

Abdomen blackish purple, with a few scattered tawny hairs, especially next the sides; at tip with abundant tawny hairs; sides above like the upper surface, with more frequent tawny hairs, below becoming still more frequent, the last two or three joints almost entirely tawny; beneath tawny, obscured near the base by pale, dirty yellow. Upper organ of male appendages (37:8, 19) three and one-half times as long as broad, of equal breadth throughout, covered with moderately long, spreading hairs; hooks directed horizontally backward, less than one-third as long as the centrum, blunt; lateral arms forming a plate appressed to the hooks, rounded or slightly angulated at the tip. Clasps twice as long as broad, the upper lobe high, rounded, a little incurved, the lower posterior angle much rounded off, the upper produced slightly to an incurved point.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....		13.75			14.5	
antennae.....		7.			7.5	
hind tibiae and tarsi..		7.25			8.	
fore tibiae and tarsi..		5.1			5.2	

Distribution (29:8). This butterfly is a characteristic member of the Alleghanian fauna, but has not been found at its extreme northern or southern limits. Its western limits are uncertain, but it is known to occur in widely different localities, as in Ontario (Saunders), Illinois (Walsh), Iowa (Parker), Wisconsin, common (Hoy), Nebraska (Dodge) and Texas (Edwards), as well as Colorado (Edwards). In the east its southernmost reported stations are Wyoming, Pa. (Shurtleff), New Jersey (Andrews, Graef, Aaron), and the vicinity of New York (Morrison, Davis).

North of these latter localities it has not been found beyond Albany, N. Y. (Lintner), excepting in New England, where, although otherwise confined to the more southern portions and especially to the lower levels, it has been taken at Milford, N.H., "scarce" (Whitney). The eastern portion of Massachusetts has furnished more localities than any other, for this butterfly has been found at Belmont (Thaxter), Wollaston and Malden (Sprague), Cambridge (Morrison), Milton (Merrill), Walpole (Guild), Wrentham (Gassett fide Sanborn), and Carver (Shurtleff). It has also been taken at New Salem (Trask), Amherst (Peabody) and Belchertown (Sprague) in the middle of the state and in Connecticut (Edwards).

Life history. Although the butterfly has so rarely been observed it is nevertheless double brooded. The earliest appearance of the butterfly is apparently in the first half of June and it continues on the wing throughout this month; a second brood appears in the second week of July, fresh specimens continuing to emerge throughout this month and remaining on the wing until after the middle and probably nearly to the end of August. This seems a reasonable inference to be drawn from the few but rather significant data at command.

According to Graef the butterfly has a sluggish flight and frequents swampy places; the latter is also the conclusion of others, who have found it in cranberry bogs. Professor Parker found it in Iowa in great abundance in 1884, in marked contrast to former years. One specimen examined by me had the pollinium of an orchid on one of its hind legs.

Desiderata. Besides the doubt concerning the seasons of this curiously coloured skipper, we are wholly ignorant of its early stages and need detailed information concerning the flight, attitudes and haunts of the imago; every additional locality will help us to a better understanding of its distribution.

LIST OF ILLUSTRATIONS.—POANES MASSASOIT.

- | | |
|--|---|
| <i>General.</i> | Pl. 37, figs. 8, 10. Male abdominal appendages. |
| Pl. 29, fig. 8. Distribution in North America. | 42:5. Neuration. |
| <i>Imago.</i> | 59:1. Side view of head and appendages enlarged, with details of leg structure. |
| Pl. 10, fig. 6. Female, both surfaces. | |

PHYCANASSA SCUDDER.

Phycanassa* Scudd., Syst. rev. Amer. butt., Hesperia pars Auctorum.
56 (1872). Pamphila pars Auctorum.

Type.—*Hesperia viator* E^ho.

O this quaint and quiet Quaker,
Bowed head would never make her
More discreet or modest;
But the Gallants pass her by,
For with tender, steadfast eye,
Straight she looks up at the sky!
Surely now, some brighter hues,
'Steal of lavenders and blues,
Would delight some jolly fellow,—
Russet Bee, with bands of yellow,
Or a sailing Butterfly,
At her feet would love and sigh,...
But to talk's no use, I know,
Still in sober dress she'll go,
And her love of heaven will show!

MARGARET DELAND.—*Houstonia caerulea*.

Imago (59: 2). Head large, provided above with two broad, transverse patches of moderately long, erect hairs in front of and behind the antennae; at the outer base of the antennae a compressed, arcuate pencil of moderately long bristles, arching over the eye, directed outward and somewhat forward, the lower bristles the longest. Front gently tumid, a little and equally surpassing the front of the eyes, nearly three times as broad as high, separated from the vertex by a delicately and scarcely impressed, straight sulcation, which at its extremities curves gently and slightly backward to the middle of the inner base of the antennae; either half of the front margin gently convex, the middle of the whole being broadly emarginate; the sides nearly straight, almost reaching the outer edge of the antennal pits. The vertex slightly tumid by being arched longitudinally across its whole breadth, but transversely scarcely convex with a faint depression in the middle, just rising to the height of the eyes, crossed at its summit by a faintly convex, scarcely elevated, fine ridge, the opening of its convexity backward, separated from the occiput by a bent or arcuate, broad and faintly impressed sulcation by which it is lengthened posteriorly so as to be nearly twice as long as the front. Eyes very large, very full, naked. Antennae inserted near the front of the summit, their interior edges separated by a space nearly four times as great as the width of the basal joint, a little shorter than the abdomen, composed of forty-four joints of which twenty-four form the club, which is about three and a half times longer than the stalk, bent to form a crook, beyond the middle of the apical three-fifths; the portion before the bend increases regularly and very gradually in size on its proximal half and then remains of nearly the same breadth, about equalling the length of two joints, until just before the hook; this consists of about eleven joints and tapers gradually to a fine point, in the basal third more rapidly than beyond; the joints of the middle of the stalk are about three and a half times longer than broad. Palpi moderately stout, the basal joints very heavily and rather loosely clothed with long scales, beyond which the greater part of the apical joint projects, clothed only, but heavily, with recumbent scales; basal joint subglobular, produced a little apically at the upper inner portion, broader than long; the middle joint large, tumid, ovate; apical joint slender, elongate, cylindrical, longer than the breadth of the middle joint and about four times as long as broad.

Prothoracic lobes large, appressed, laminate, subcuneiform; when viewed from the front, narrowing from above downward, the upper surface convex, the interior edges attinent. Patagia large, the posterior lobe large, broad, equal to the rounded tip, half as broad as the base and as long as it; the whole piece somewhat shorter than the breadth of the head.

* Φῦκος, ἄνασσα, a painted lady.

Fore wing (42:12) almost twice as long as broad; the lower outer angle falling considerably beyond the middle of the costal margin; the costal margin gently convex at the base, beyond nearly straight; the outer margin regularly and gently convex, the tip not at all produced. Costal nervure terminating a little beyond the middle of the costal margin; the subcostal nervure distant from the costal margin, the second nervule arising just before the middle of the wing; cell more than three-fifths as long as the wing, rather slender, nearly equal in its distal half; first median nervule arising before the middle of the cell, the second at the middle of the wing; internal nervure rather long, apically turned upward gradually and striking the submedian.

Hind wing a fourth longer than broad; the costal area strongly lobed at the base; the costal margin beyond it scarcely convex; outer margin strongly and regularly rounded above the middle of the medio-submedian interspace which is slightly excised; the anal angle well rounded. First median nervule arising before the branching of the subcostal at the middle of the basal half of the wing, the cell being unusually short.

Legs with slight clothing; the femora with thin fringes of not excessively long, curving hairs; all the tibiae furnished with distant, delicate, erect spines, generally larger and more erect upon the anterior outer surface, longer and more prominent in the middle pair; femora 2, 1, 3; tibiae 2, 3, 1; tarsi 3, 2, 1; fore femora distinctly and considerably longer than the hind pair, and about three-quarters the length of the middle pair; fore tibiae only a little more than half as long as the fore femora, and half the length of the middle tibiae, which are barely longer than the hind tibiae; foliate epiphysis of fore tibiae conspicuous, originating at about the middle of the tibia, and extending somewhat beyond its tip, shaped like the longitudinal half of a cylinder, apically tapering and bluntly pointed; the other tibiae furnished at tip beneath with a pair of very unequal, long and slender spurs; the hind tibiae also with a similar pair of subequal spurs, slightly beyond the middle of the under surface; tarsal joints 1, 2, 3, 4, 5, excepting on the fore tarsi, where the apical joint is nearly half as long again as the penultimate; fore tarsi a little longer than the middle tibiae, a little more than two-thirds as long as the hind tarsi; all the tarsi with a triple row of moderately long, delicate spines, the apical ones of each joint slightly longer than the others; basal joint of the tarsi scarcely as long as the rest together; second joint nearly three-fifths as long as the first; claws not very large, delicate, strongly falciform, pointed, overhung by a pair of long, curving, divergent bristles, as long as the apical joint; pulvillus large, rounded; paronychial with the lateral lobe broad, short, tapering, scarcely more than half as long as the claw, apically rounded; inferior lobe threadlike or slender, cylindrical, of similar shape, both delicately covered with hairs.

Upper organ of male abdominal appendages of small size, not so long as the clasp, very strongly arched, much broader than high, of irregular surface; the short, nearly straight fingers of the hook and the lateral arms lie side by side, and are apparently soldered, excepting next the extreme tip, where all meet, after a slight lacuna. Clasp very large and very broad and equal throughout the upper edge, beyond a deep pre-apical notch, denticulate.

Of this genus, composed as far as known of only a single species, whose distribution is given below, only the perfect insect is known.

The butterflies are among the largest of our Pamphilidi, and are remarkable for their large, broad wings, with a form of marking very like an exaggerated *Poanes*. The males and females differ in the color of the spots on the upper surface of the fore wings.

EXCURSUS LXIV.—POSTURES AT REST AND ASLEEP.

Bathed in the summer moon's white light
 Lady Butterfly folds her wings and sleeps;
 A grass blade her couch, which slowly keeps
 Swinging and swinging the livelong night.

J. M. S.

BUTTERFLIES, as a general rule, are very dainty about alighting after flight, appearing to regard the position they shall take with some concern, hesitating more or less about the place they choose; sometimes they hover about a spot or approach and leave it many times before pitching; at others two or three quivers of the wing are all that indicate their daintiness. Moths, on the contrary, usually come plump to a stop and settle, much as if they had been thrown at the spot; while among the butterflies, those that in this respect resemble the moths the most closely are the lowest family, the skippers, and some Nymphalidae which are protected by their colors when alight.

Alighted only for a brief rest, or to sun themselves, or to suck the juices of some flower, butterflies usually keep the wings more or less spread wide open; though in feeding, especially if it be in companies, or at rest for a longer time, or, as it were, for observation, the wings are usually closed tightly back to back; among the Pamphilidi, however, there is a very prevalent custom which oddly combines these two, the hind wings being held horizontal, the fore wings perpendicular or a little oblique; this gives them a curiously disjointed look, the purpose of which is not easy to see; perhaps a comparative study of the attitudes in males and females, or in those species in which the males have and those where they have not a discal stigma, may lead to some result.

The need of feeding with erect wings is plain enough in certain instances, as where crowds mingle along the edge of a muddy rut in the road; and that the same posture is almost invariably assumed at complete rest, as for the night,* is also easily explained, since that presents the least exposed surface, and one which far more than the upper side of the wings, sometimes very completely, resembles in tint and often in texture or markings, the background chosen for rest.

No creatures seem to be more sensitive than butterflies to warmth and sunshine. We have alluded in a previous excursus (p. 419) to the diurnal movements of even hibernating butterflies; and one is amused at watching with what precision a Melitæid for example, or a Polygonia, sidles around on alighting, to expose the broadest possible surface to the sun. Startle one of the latter, but not sufficiently to make it leave the spot, and with what a snap the wings close, and in place of the burning colors which seem

*Some Hesperidi which rest by day with outspread wings sleep with roofed wings like moths, and very likely all of them do; we know little of their sleeping attitudes.

to have imbibed the sun's warmth, your butterfly, with the dead leaf or dusty color of its under surface brought to view, has become nearly invisible.

Butterflies are not much given to walking, but in the use of their legs they have many little peculiarities which generally mark whole groups. Thus the Satyrids always walk by a series of nervous twitches in a very bungling fashion unknown, I believe, outside of this group. Many Theclidi never remain on the surface of the leaf or twig on which they have pitched, facing in the direction in which they have alighted, but turn part way around to face another way, and that with no reference to the sun; they do the same when the sun is wholly obscured.

At sleep, the wings are packed away into the smallest compass, as already stated; with the exception of some Hesperidi, the wings erect back to back, the fore wings slid down between the hind pair, so that only the latter and the apex and front edge of the former are visible*. There is, however, more variety in the method of treating the antennae, some, like the Satyrinae, sleeping with these wide spread, others tucking them between the wings, others bringing them together beside the front edge of the wings; sometimes only the stalk of the antennae lie between the wings, the clubs appearing beyond as if crowded out by the tight shutting of the wings. In all cases where the antennae are brought together this is the final action of the butterfly before complete repose; at first the antennae remain without, looking in different directions like sentinels; and it is only gradually that they are brought to the position of complete rest.

The moralist tells us, and his warning is seconded by the psychologist, that as every repetition of an action makes it easier than before, so any propensity indulged in wears ruts, as it were, in our character, and habits become fixed; it is easier to travel given roads than others, and, what is fullest of portent, our propensities are plainly bequeathed to our descendants. The lives of frivolous butterflies admonish us in like fashion. Observe how wonderfully alike are the actions of butterflies of the same group, i. e., descendants of the same stock; their habits have become ingrained by repetition through the ages; habits which it were almost certain destruction not to obey, since in nearly every one some protective meaning may be found; habits which run so through groups that the keen observer may foretell the apparently untrammelled actions of creatures he has never seen alive, with as great a percentage of accuracy as the best informed "clerk of the weather" may predict the action of the morrow's winds.

The behavior of butterflies then has clearly its story to tell of the past and its relationships, and we shall not be likely to reach the fairest conclusions regarding the phylogeny of butterflies until we have given these their

* Wittfeld, however, says that the southern Euphœades palamedes sleeps with spread wings, and I have seen a European *Thais* do the same in confinement.

full value. Up to the present no proper investigation has been made in this direction; only a few of the most patent of tricks and ways of butterflies have been noted; a wide and open field lies before the enquirer, and it is for his use that I have tried to bring together in the present work a few facts concerning the postures and behavior of butterflies in different circumstances. These are, however, still too few whereon to base any general statements, likely to require no important modification on future investigation, and I leave them for the present barren of result, in the hope of enticing some one to enter a promising field, and perchance relieve these facts of their present stupidity.

PHYCANASSA VIATOR.—The broad-winged skipper.

Hesperia viator Edw., Proc. ent. soc. Philad., iv: 202-203, pl. 1, fig. 5 (1865).

Pamphila viator Klr., Syn. cat. Lep., 608 (1871);—Speyer., Can. ent., xv: 147 (1888);—French, Butt. east. U. S., 347-348 (1886).

Phycanassa viator Scudd., Syst. rev. Am. butt., 56 (1872).

Isoleinon viator Hew., Cat. coll. diurn. Lep., 228 (1879).

Figured also by Glover, Ill. N. A. Lep., pl. I, fig. 17, ined.

It was an hour of universal joy,
The lark was up and at the gate of heaven,
Singing, as sure to enter when he came;
The butterfly was basking in my path,
His radiant wings unfolded.

ROGERS.—*The Pilgrim*.

Imago (17:20). Head covered above and in front with mingled black and tawny hair-like scales, tinged strongly with olivaceous, concealing the short, black-brown scales of the base. Eyes edged behind with a narrow circlet of whitish scales, closely appressed to the eye; cornea black-brown, overhung by a compressed arching pencil of mingled black and tawny bristles, the uppermost shortest and tawny. Antennae dark brown above, clay brown on the lower outer surface as far as the middle of the club; all the joints above flecked and apically narrowly annulate with clay brown as far as and including the few basal joints of the club; club itself pretty uniform, blackish brown, with purplish reflections over all the thicker portions above and on the sides, as well as to a certain extent upon the apical half below; the hook naked beneath and ferruginous, including the apical joints of the club proper, and furnished with short, tawny bristles, about as long as the joints; on the posterior face, however, the hook is flecked somewhat profusely with clay yellow scales in a narrowing patch. Palpi dirty white below, with a few intermingled long black scales; the apical joint black, the upper surface and upper part of the sides of the middle joint with mingled black, fulvous and whitish scales; tongue black at base, beyond blackish castaneous, somewhat tinged mesially with testaceous.

Thorax covered above with purplish black scales concealed to a great extent by a mass of long, olivaceous tawny hairs, intermingled with some blackish ones; femora purplish black, flecked on all sides rather profusely with clay yellow scales and furnished beneath with a few long, blackish and whitish scale-hairs; tibiae much the same, but not so dark at base and rather more densely clothed; tarsi clay yellow beneath, brownish above; all the spines luteo-testaceous; spurs the same, but clothed with pale yellow scales to the blackish tip; claws testaceous; apical hairs white.

Wings above blackish brown marked with dull tawny, and in the females with pale yellowish white. Fore wings with a double rhomboidal spot near the apex of the cell, either tawny (♂) or pale yellowish white, flecked at the edges with brownish yellow

(♀); it consists of two more or less confluent, longitudinal, oval dashes, the lower the inner; there is an extra-mesal irregular series of unequal spots of a similar color, varying according to the sex, of which two or sometimes three are found in the subcostal interspaces, midway between the cellular spot and the apex of the wing; the lowermost largest, twice as long as broad, the next above not more than half as long, and of somewhat similar shape but shorter, and the third and uppermost, when present, rarely more than a mere dot; the anterior edges of these spots lie in a line perpendicular to the costal margin; the next spots of this series, with the exception of a rarely occurring collection of scattered scales in the interspace beyond the cell, somewhat more than half way between the cellular spot and the margin, are situated in the median interspaces, equally near the base; the uppermost, in the second median interspace, midway between the cellular spot and the margin of the wing, is generally triangular, lunulate, and occupies the entire width of the interspace but does not encroach upon the nervure; that in the first median interspace is of a somewhat similar form but more rounded basally, sometimes truncate, its outer border just outside the inner border of the spot above; this is followed by a spot in the upper half of the medio-submedian interspace, about as large as that in the second median interspace, but transverse and rhomboidal or subrhomboidal; and this by an elongated streak sometimes tawny in the female, often confluent with the above, which runs along the lower half of the medio-submedian interspace half way or less toward the base. *Hind wings*: Whole discal portion of the wing tawny, excepting certain parts in the female, especially in the upper median and subcostal interspaces, which may be pale tawny, leaving in all cases a broad margin with wavy outline, twice the width of an interspace, around the whole outer margin; inner margin also of this blackish brown color above the subcostal nervure; the inner margin to a similar extent gray by an intermingling of fulvous hairs and pale tawny scales; the central discal, tawny spot, however, is traversed by veins of the color of the ground, often broadly marked, especially in the female, and including a distinct streak across the extremity of the cell and filling the extreme base of all the interspaces. Fringe of all the wings pale brown apically, blackish brown at base.

Beneath, dark gray brown, the fore wings sometimes much deeper in color, becoming blackish brown, especially in the males. *Fore wings* with the basal two-thirds of the costal margin as far as the cell more or less heavily washed with tawny, including a tawny spot more or less vague at the extremity of the cell, across the middle or outer edge of which runs a slender blackish bar marking the termination of the cell. The extra-mesal spots of the upper surface are repeated beneath, the subcostal ones whitish in the female, occasionally slightly paler than the other markings in the male; the remaining markings are more or less confluent in both sexes, generally much more so than above, and are fulvous in both sexes, though rather paler in the female than in the male. *Hind wings* differing considerably from the upper surface, in that the markings are largely confined to a broad obscure bar, slightly paler only than the ground, which extends from the base filling the entire cell and running to the outer limit of the extra-mesal row of spots, which here consist, above this bar, of a large, longitudinal, oval or sublunate spot in the middle of the subcostal interspace, not reaching its upper margin, and of a straight series of similar spots in the median and medio-submedian interspaces, especially the former, which runs subparallel to the outer border, but from the cell inward at an increasing distance from the outer margin, the edges of those in the median interspaces near the centre of their respective interspaces; these are of a pale fulvous color, decidedly paler in the female than in the male, often becoming almost dirty white, and are bounded by a darker cloud, most distinct on the outer side. Fringe of all the wings tolerably uniform, very pale brown, the edge of the wing itself marked by a fine thread of brown.

Abdomen blackish brown, much flecked, especially upon the sides, with brownish yellow scales; beneath with pale clay yellow. The centrum of the upper organ of the male appendages (37:10) is remarkable for the independent tumidity of each half above, at the point of greatest bend in the upper organ, the apical portion of the latter developing a similar central boss just next the base of the hook; the lateral arms are

united with each other and the hook for two-thirds of their length. Clasps almost two and a half times longer than broad, the preapical slit penetrating one-third through the clasp, the outer margin broadly rounded, the upper margin beyond the slit inconspicuously and distantly denticulate, incurved.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	18.	20.	20.5	22.	23.	23.
antennae.....	9.7		9.8	10.5		10.5
hind tibiae and tarsi..	9.			11.		11.
fore tibiae and tarsi..	5.	5.			6.1	6.1

Described from 4♂, 3♀.

The distribution of this butterfly (30:1) is imperfectly known, although it is one of the very largest of our Pamphilidi. It has been taken at widely separated points. In the south I know it only from New Orleans, La. and Florida, though Strecker gives Carolina and Texas; this is quite probable, as it is certainly a southern and not a northern species; yet in the northern states it is reported from Nebraska, not given on the map (Dodge), northern Illinois (Edwards), Wisconsin abundant (Hoy), and New Jersey—Atlantic City (Aaron), Hoboken (Sachs, Meyer, Andrews), and it has twice been taken in Canada, at Hamilton (Moffat) and Toronto (Geddes).

It has even been reported from New England. I have specimens, of the origin of which I know nothing, marked from Massachusetts, and Mr. Edwards long ago wrote me that Mr. Akhurst had two specimens taken by Chase at Holyoke, Mass.

I cannot learn that a single date exists to indicate the seasons of this insect, and we are totally ignorant of every feature of its history or of its earlier stages.

LIST OF ILLUSTRATIONS.—*PHYCANASSA VIATOR*.

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| <p><i>General.</i>
Pl. 30, fig. 1. Distribution in North America.
<i>Imago.</i>
Pl. 17, fig. 20. Both surfaces.</p> | <p>Pl. 37, fig. 10. Male abdominal appendages.
42:12. Neuration.
59:2. Side view, with head and appendages enlarged, and details of leg structure.</p> |
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ATRYTONE SCUDDER.

Atrytone* Scudd., Syst. rev. Amer. butt., 58
(1872).

Hesperia pars Auctorum.
Pamphila pars Auctorum.

Type.—*Hesperia iowa* Scudd.

The virtuoso thus, at noon,
Broiling beneath a July sun,
The gilded butterfly pursues,
O'er hedge and ditch, through gaps and mews;
And, after many a vain essay,
To captivate the tempting prey,
Gives him at length the lucky pat,
And has him safe beneath his hat:
Then lifts it gently from the ground;
But ah! 'tis lost as soon as found;
Culprit his liberty regains,
Flits out of sight, and mocks his pains.

COWPER.

Imago (59:3). Head large, heavily clothed with moderately long hairs arranged in transverse masses; outside of the antennae a rather short, scarcely spreading bunch of slightly arcuate bristly hairs, directed outward and reaching about one-fourth way over the semi-circumference of the eye. Front tumid and protuberant, greatly surpassing the front of the eye, most prominent transversely just below the middle and on the middle half, above which it is slightly hollowed longitudinally in the middle, nearly two and one-half times broader than long, the front margin a little concave and emarginate, laterally rounded off and forming with the sides a regular curve to the outer edge of the antennae, separated from the vertex by a transverse, impressed, straight sulcation a little in advance of the middle of the antennae. Vertex scarcely tumid, very slightly and uniformly elevated above the level of the eyes, considerably longer than the front, separated from the occiput by a slightly arcuate, almost imperceptibly impressed line. Eyes large, pretty full, nearly circular, naked. Antennae inserted with their hinder edges in the middle of the summit, their interior edges separated by about two and one-half times the diameter of the basal joints, the whole antenna fully as long as the abdomen, composed of 36-39 joints, of which nineteen form the club, which is about half as long as the stalk, the crook of which consists of eight or nine joints, but occupies less than one-third the length; the inflated portion of the club is cylindrical, increases regularly and rather slowly in size, largest at about the 6th-8th joint and about as broad as the length of two and one-half joints, decreasing again, gradually at first, more rapidly on the crook which tapers to a delicate point, the last joint being much longer than broad at base, the fourth or fifth joint from the tip being of the size of the stalk; middle joints of the stalk about two and one-half times longer than broad; the third about four times as long as broad. Palpi short and very stout, less than twice as long as the diameter of the eye, clothed very compactly with a mass of long scales, beyond which the apical joint, clothed only with recumbent hairs, scarcely protrudes; basal joint small, globose, somewhat cup-shaped, tumidly produced at the anterior part of the tip and so slightly broader than long; second joint tumid, depressed posteriorly, a little arcuate, but otherwise cylindrical, the ends rounded off, more bluntly rounded at tip than at base, as broad as the basal joint and nearly three times as long as broad; apical joint quite minute, ovate, a little pedicellate, half as long again as broad, bluntly rounded at tip and scarcely more than one-fourth as long as the breadth of the middle joint.

Prothoracic lobes pretty large, appressed, laminate, oval, angulated at the base, half as long again as broad, as long as the shorter diameter of the eye. Patagia very broad at base, the posterior lobe less than half as broad, as long as the base, tapering, pretty regular, but the point well rounded off; the length of the whole three-fourths the width of the head.

* *depraving*, the unwearied one.

Fore wing (42:7) nearly twice as long as broad; the male sometimes a little longer; the lower outer angle falling a little beyond the middle of the costal margin, costal margin straight; outer margin regularly rounded, the tip only a little, in some males distinctly, produced. Costal nervure terminating considerably beyond the middle of the costal margin; subcostal nervure moderately distant from the costal margin, the second nervure arising from the middle of the wing; the cell two-thirds the length of the wing, slender, subequal in the apical half; first median nervure arising midway between the base and the second, the second beyond the origin of the second subcostal nervure; internal nervure short, terminating in the submedian.

Hind wing rounded, triangular, a little longer than broad; the costal margin beyond the strong basal lobe straight; outer margin as in *Phycanassa*. Subcostal and first median nervules arising at similar distances from the base and scarcely beyond the basal third of the wing.

Legs 2, 3, 1; femora clothed as in *Poanes*; hind tibiae with a very thin fringe of hairs on the basal half and all the tibiae armed above with minute, distant spines, those of the fore tibiae inconspicuous. Femora 2, 3, 1, sometimes the hind femora scarcely so long as the fore; tibiae 2, 3, 1, the middle sometimes slightly longer than the hind pair; tarsi 2, 3, 1; fore and hind femora more than two-thirds the length of the middle femora and scarcely shorter than the hind tibiae. Fore tibiae scarcely two-thirds the length of the fore femora and more than half the length of the middle or hind tibiae. Leaf-like appendage of the fore tibiae small, slender, originating in the middle of the outer two-thirds of the joint, scarcely, if at all, surpassing its extremity, about five times as long as broad, nearly straight, tapering toward the pointed tip; other tibiae with an apical pair of very long and slender spurs; and the hind tibiae with a similar but slightly shorter pair in the middle of the apical two-thirds. Tarsal joints 1, 2, 3, 4, 5, the apical joint slightly longer than the penultimate on the fore legs; fore tarsi fully two-thirds the length of the middle and hind tarsi, of the length of the middle femora; all armed beneath with a triple series of long and slender spines, the apical ones of each joint much longer than the others; basal joint as long as the following three or four joints together, the second about half the length of the first. Claws small, slender, tapering, strongly and regularly curved and finely pointed. Pad small, transverse. Paronychia bifid, the upper lateral, laminate, triangular, straight, as long as broad and only extending half way to the tip of the claw; the lower as far toward the bottom as possible, nearly as large as the apical half of the claw and curving in an opposite direction; in one extra New England species, however, the lateral branch is lanceolate, as long as the claw and curving slightly in the same direction.

Second abdominal segment half as long again as the first, a little longer than the third; beyond, the segments decrease regularly, the eighth as long as the sixth, but not extending down the sides as the seventh, entire. Upper organ of male appendages small, reaching as far as the clasps, very strongly arched, tapering from the base apically, or broadening just beyond the base and then tapering, depressed, the hook shorter than the centrum, double, but the two halves so closely compressed as often to appear as if one, depressed, tapering pretty regularly; lateral arms forming a single, moderately stout, conical piece, directly horizontally backward, sometimes in conjunction with the hook, sometimes below it. Clasps large, very broad, less than twice as long as broad, the greater portion equal and straight, but slightly convex, the extremity variously armed by projections from the upper and lower angle, the upper sometimes nearly obsolete, always smaller, the lower rather broad, upturned.

Egg. Pretty high, broadest at the base, narrowing rather rapidly and regularly, the top broadly but not greatly flattened; surface broken up by very slightly raised lines into polygonal, usually elongated, hexagonal cells, and so suboval in appearance. Micropyle consisting of a minute central circle, bordered by four divergent canals, surrounded by six or eight rounded, kite-shaped cells, twice as long as broad, surrounded again by a mass of nearly circular, polygonal cells.

Caterpillar at birth. Head large, considerably higher than broad, broadest below the middle, narrowly and regularly rounded above, with scarcely the least depression at the suture; triangle considerably higher than broad, reaching above the middle of the head; special papillae, bearing long, delicate hairs, are found outside of the triangle, on either side, just above its summit and somewhat above the middle, as also other lateral hairs in the ocellar field, at the widest point of the head and less than midway between this and the summit; ocelli forming a curving row, four in number, equal, equidistant; third antennal joint half as long again as broad, cylindrical but arcuate.

Body slender, equal, tapering apically; the dorsal thoracic shield narrow, situated on the anterior portion of the segment, bearing distant, erect or forward curving, tapering hairs; segments of the body apparently divided into five subsegments, of which the anterior is as large as the remaining together, and the first of the smaller ones a little larger than the others; bristles scarcely tapering, scarcely enlarged apically, erect, about half as long as the segments, arranged in longitudinal rows, the position of which has not been determined, but some of the bristles are anteriorly, some posteriorly placed; terminal segment with three pairs of very long, recurved bristles at the middle and posterior end of the segment, besides two pairs anteriorly placed, of shorter, similar bristles, all apparently in the subdorsal series.

Mature caterpillar. Head subglobose, well rounded, broadly rounded beneath, strongly and regularly arched above, where the curve is scarcely interrupted by a slightly incised suture; broadest just above the ocelli, of about equal breadth and height, depressed below, narrowing very gradually above, slightly protuberant in front, below; triangle distinct, the inner one terminating in the centre of the head, half as high again as broad, regular; ocelli six in number, five arranged in a regular, arcuate curve, the lowest directly outside the base of the antennae or slightly farther back, as far removed from the fourth as the fourth from the second; the first four subequidistant, all of these subequal; the sixth smaller, directly above the fifth, forming with it and the third the angle of a rectangle.

Body plump, cylindrical, tapering slightly on the thoracic segments and behind the sixth abdominal segment; first thoracic segment with an obscure thoracic shield, deeply and transversely sulcate, not reaching the spiracles by the length of the latter; followed anteriorly by a naked space, and then abruptly descending to an excessively short collar; anal plate of the last abdominal segment broadly rounded, subtruncate; segments divided very obscurely into seven subsegments; the first and second faintly separated from each other, as well as the sixth and seventh; the first and second together more than equalling the three following in length; studded profusely with excessively minute papillae, bearing equal, short, delicate, erect hairs, forming a pile; inferior gland of first abdominal segment obscure, transverse; thoracic legs rather feeble; abdominal legs not so stout as usual; there is a central lateral series of exceedingly minute, crateriform disks, transversely oval in shape, those of the second and third thoracic segments single, lower than on the other segments, that on the second directly at the upper edge of the thoracic callosity; the first thoracic segment has also a pair midway between the spiracle and the legs, or a little nearer the latter; a suprastigmatal and infrastigmatal series of the same, the former transversely oval, the latter circular and slightly larger, situated as far behind, as the suprastigmatal series is in front of, the spiracles; and a lateroventral series of transverse, broad, oval or circular disks, as large as the spiracles, on the apodal abdominal segments.

Chrysalis. The specimen of *A. zabulon*, upon which I had intended to base the description of the genus having been lost, I have only a few fragmentary notes. The free portion of the tongue lies close to the body, and reaches as far as the middle of the seventh abdominal segment, the wings as far as the middle of the fourth segment; the prothoracic spiracle is prominent, ovoid, edges slightly raised, transversely furrowed.

This genus of butterflies is peculiar to eastern North America, extending over the whole of the United States lying east of the Rocky Mountains.

There are four or five species in the genus of which two occur in New England, but only one is common there.

The butterflies of this group, very numerous in individuals, are of small size, tawny above, broadly bordered outwardly with dark brown, often heavily infuscated next the base, the fore wings provided with an oblique dark streak at the tip of the cell, the male without a discal streak. Beneath, the color is nearly uniform but much less vivid, or the outer margin shows the same band as above; the hind wing is dark with a broad, tawny, median band, sometimes expanding into a large spot. There is, however, one exception in the females of the common New England species, which are dimorphic, one form resembling the male type, the other more or less infuscated or melanic throughout and therefore almost devoid of markings.

The history of two or three of the species is known. The butterflies are all single brooded at least in the north.

The species which possesses dimorphic females and which in general differs in appearance from the others, forming a sub-group apart, winters either as a chrysalis or a mature caterpillar, while the others probably hibernate as partly grown caterpillars. The butterflies fly in meadows in the hottest sunshine, and are strong and active in movement. The caterpillars are very slow feeders, live on grasses and inhabit rude nests made by fastening together several blades of grass generally near their base.

The eggs are nearly hemispherical, broad and large, a little flattened above and of a greenish white.

The caterpillars just born are white with a large black head, a narrow black shield on the first thoracic segment, scarcely expanded bristles arranged in longitudinal rows and two pairs of very long, recurved, tapering bristles on the last segment, besides four at the edge directed backward. The mature caterpillars are fat, cylindrical, elongated creatures tapering equally at the two ends, uniform in color, having a ferruginous head of no great size and a speckled brownish body.

The chrysalids are of the usual form, livid brown, and covered with a whitish bloom, the tongue reaching the extremity of the seventh abdominal segment. The transformations are undergone in a vertical nest of the larva, or one similar to it but completely closed to view, and in this the chrysalis is erect, apparently with no median girth whatever.

EXCURSUS LXV.—THE ENEMIES OF BUTTERFLIES.

The violets died with the day's last breath;
The roses slept when the wind was low;
What chanced to the butterflies who can know?

LOUISA MOULTON.

WHEN we consider that the numbers of butterflies of any given species remain about the same from year to year and that the females generally

lay from two hundred to five hundred eggs, it is plain that there must be a vast loss of life. Certainly ninety-nine one-hundredths of every brood perish before maturity, and even after maturity is reached a very considerable proportion of the remainder must come to an untimely end within a day or two of birth. The chief sources of destruction are bad weather, creatures which seize upon and devour them, and parasitic enemies which place their young within their bodies.

More must be laid to bad weather than is, I think, generally considered. I have frequently observed that in a heavy storm a very considerable number of new born caterpillars have been washed from their stations to the ground, and doubtless have perished; and although older caterpillars, chrysalids and eggs are rarely if at all injured in this way, I have often noticed the disastrous effect of a severe rain upon the butterflies themselves. It is especially true when the butterflies are either freshly born or are somewhat old and enfeebled. One Saturday just past the middle of June I took careful notes of the butterflies which were abroad, and on the following Wednesday (a two days' rain intervening) took special pains to note the relative numbers of the same species, the two occasions being only three days apart. Now while on the first day worn specimens of *Phyciodes tharos* were by no means uncommon, on Wednesday but two were seen, besides one fresh specimen, doubtless emerged since the rain; *Eurymus philodice*, which had not been uncommon, was scarcely seen at all; *Heodes hypophlaeas* was in a similar case; *Thorybes pylades* was not one-fourth so abundant as on the earlier date; *Thymelicus mystic* was seen only three or four times to some double that number previously; and of *Limochores taumas* only one or two seen where ten or a dozen had been observed on the previous day; *Polites peckius* was not one-fourth so abundant as before; while *Ancyloxypha numitor* was hardly seen at all on Wednesday, when it had been plenty enough the previous week. The only exception among all the butterflies specially noted on the two occasions was with *Cissia eurytus*, the numbers of which did not seem to be at all affected, and which perhaps owed its exemption to its forest habits, where it would be better protected from a storm.

Insectivorous animals seem to be especially dangerous foes in earliest life, the eggs and young larvae before they have moulted being subject to many marauders in the shape of ants, spiders and crickets, and doubtless also snails and slugs; but the caterpillar is subject to attacks from this source throughout its entire though brief life. At this caterpillar stage birds are their principal external foes. Many observers in this country have recorded the contents of the stomachs of birds; some of these observations, and especially those of Professor Forbes, have been made and recorded with the greatest care; but among a considerable number of birds examined by him, not a single one was found to contain the caterpillars of but-

terflies; other insects and especially the caterpillars of certain moths which were then swarming in profusion formed the principal food. Gentry alone has thought that he has obtained proof of the presence of a large number of caterpillars of butterflies in the stomachs of various birds. Birds also, as is well known, attack the perfect insect, but, while I have frequently seen moths snatched up on the wing by birds, I have never been so fortunate in all my experience in the field as to see a single butterfly in a bird's bill; and the number of instances that I have been able to find on record in the northern parts of the north temperate zone are exceedingly few, nearly all the prominent instances that have been mentioned having been taken from the tropics, where I have no doubt the perfect butterflies form a not inconsiderable portion of the food of many birds. I have applied to several persons whose investigations of the contents of bird-stomachs have been very extensive and in all cases the report has been that these contents are made up in large measure of small Coleoptera and Orthoptera and of caterpillars of moths. In the case of nocturnal birds, like the whippoorwill, night hawk and owls, moths are frequently taken, but the very fact that these birds are nocturnal makes it improbable that they often obtain butterflies for their food. Mr. C. J. Maynard, who has recorded the contents of the stomachs of over three thousand birds, thinks that birds seldom devour either butterflies or moths. There are, however, he writes, exceptions; for instance, the nocturnal birds will eat the larger nocturnal moths; "wallows, that we should suppose would devour immense quantities of the smaller diurnal moths seldom eat them, their food consisting almost entirely of Coleoptera and Diptera." But butterflies are certainly sometimes eaten with us, for several cases are on record where capture has been seen and I have myself noted one instance where *Euphocaes troilus* was unquestionably captured at no great distance from me by a bird. Other enemies in this state are the Odonata; "even," says Edwards, "the heavy bodied, great winged *Papilio*s cannot escape these pirates of the air." Wasps, too, are their enemies as the account, above, of the capture of *Pieris rapae* shows. I once observed a bedraggled *Basilarchia arthemis* in the middle of August fluttering in the road in the clutches of a large *Vespa* which had seized the butterfly as it was sunning itself in the path. The two struggled together for some minutes, while I observed them, the crunching of the wasp's mandibles all the while audible; at last one front wing came off at the base and at once was seized by an ant that had been an excited witness of the contest and carried off. After the lapse of another minute the other front wing was severed. Still the crunching went on, still the butterfly vainly endeavored by beating its wings to escape its deadly foe.

The third class of enemies are the parasitic four-winged and two-winged flies. Although no proper attention has been paid to these in our country

and though they can rarely be obtained otherwise than by attempting to rear eggs and caterpillars found in the field, it is not a little surprising to know that already nearly one-third of the butterflies described in the body of this work are known to be attacked by special hymenopterous parasites; and although many parasites attack indiscriminately a considerable number of species, an equal number of hymenopterous parasites are known which attack one caterpillar alone. This does not include six or eight species described in the appendix, presumed or known to be hyperparasitic; that is, to be parasitic upon the parasite itself. Then besides these there are five others which attack exclusively the eggs of butterflies. Some of these ichneumons lay a single egg within the body of their caterpillar host, the whole of whose contents are required to sustain it, while others lay an enormous number, so that when they emerge from the body of their moribund host or from the chrysalis shell, they seem to swarm in incredible numbers; or if previous to this the body of the caterpillar be opened, it will seem to be quite choked up with the squirming bodies of the parasitic maggots. A caterpillar, fair to all outer appearance, may be only a peripatetic banqueting hall of these horrid fiends. In many cases the caterpillar goes on to pupation before the exclusion of the parasite, these emerging from the body of the chrysalis. This is most frequently the case with dipterous parasites which are also doubtless exceedingly numerous. In the present work thirteen are described, all belonging to the Tachinidae, and they are known to attack no less than sixteen species of butterflies.

The life, therefore, of a butterfly is one of imminent danger from birth, nay before birth, to death, and this sufficiently accounts for the extraordinary efforts which nature seems to put forth to protect them in their various stages by coloring, by form, or, in some cases, by evidently noxious properties.

Table of the species of Atrytone, based on the mature caterpillar.

Head white, streaked vertically with black; dorsal thoracic shield black.....	logan.
Head uniform dark brown; dorsal thoracic shield dark fuscous.....	zabulon.

Table of species, based on the chrysalis.

Greenish white, head and tail black.....	logan.
Livid, with fuscous markings.....	zabulon.

Table of species, based on the imago.

Under surface of hind wings almost uniform tawny.....	logan.
Under surface of hind wings with a broad, transverse, extra-mesial belt of tawny, on a dark brown ground.....	zabulon.

ATRYTONE LOGAN.—The sachem skipper.

Hesperia logan Edw., Proc. ent. soc. Philad., li: 18-19, pl. 1, fig. 5 (1863); Trans. Amer. ent. soc., i: 288 (1867).

Pamphila logan Kirby, Syn. cat. Lep., 607 (1871).

Atrytone logan Scudd., Syst. rev. Amer. butt., 56 (April, 1872).

Isoteinon logan Hew., Cat. coll. diurn. Lep., 228 (1879).

Hesperia delaware Edw., Proc. ent. soc. Philad., li: 19, pl. 5, fig. 2 (1863).

Thymelicus delaware Kirby, Syn. cat. Lep., 610 (1871).

Atrytone delaware Edw., Syn. N. A. butt., 44 (July, 1872).

Pamphila delaware Edw., Cat. Lep. Amer., 54 (1877);—French, Butt. east. U. S., 342-343 (1886);—Mayn., Butt. N. Engl., 59, pl. 7, figs. 90, 90a (1886).

Pamphila vitellus Stueck., Cat. Amer. Macrolep., 171-172 (1878).

Papilio—Abb., Draw. Ins. Geo. Brit. Mus., vi: 90, figs. 130-132 (ca. 1800).

Figured also by Glover, Ill. N. A. Lep., pl. G, figs. 4, 6, ined.

[Not *Papilio vitellus* Fabr.]

Across the fields, inconstant as the air,
The butterfly flits on her aimless way.

R. B. WILSON.—In *September*.

Above all human praise
The hands of Heaven shall raise
A monument of fame,
On which the noble name
Of Logan shall be traced,
And never be effaced.

TAPPAN.—*Hesperia*.

Imago (17: 17, 19). Head covered above with bright, tawny hairs, with a few slightly paler and sometimes a few blackish hairs; within and without the antennae a small tuft of black hairs; encircling the back of the eyes and below them a series of whitish straw yellow scales; palpi with the first joint whitish straw yellow; second joint lemon yellow, paler at base, brighter at tip, and having, as viewed from above, a fulvous tinge; the outer half of the upper surface, which is appressed to the face, and the upper portion of the inner surface black, and a line of a few scattered black hairs follows the front lateral edge; last joint black, the under surface a little yellow. Antennae pale lemon yellow, the joints of the stem narrowly interrupted at the tips below with black, the upper outer surface mostly, the joints toward the club flecked a little with yellow; club black above, excepting two or three of the basal joints, which are orange, black tipped; beneath mostly pale yellow, merging into orange, the crook naked, dark castaneous, the apical joint blackish.

Thorax covered above with bright, tawny hairs, tinged with olivaceous, excepting on the prothorax and patagia. Beneath, the hairs are rather pale yellow, tinged with fulvous toward the base of the wings. Femora pale lemon yellow, whitish above; tibiae and tarsi pale orange, the tibiae paler beneath; leaf-like appendage dusky; spurs pale orange, minutely tipped with testaceous; spines testaceous; claws reddish; pad (and paronychial) blackish fuscous.

Wings above bright tawny, brighter in the ♂ than in the ♀. Fore wings with all the veins, excepting in the ♂ and sometimes in the ♀, the costal nervure and the basal half of the subcostal nervure before its divarication, distinctly traced in blackish, the median nervure as far as its divarication much more heavily than the others, especially in the ♀, where the bordering becomes a patch; the outer limit of the cell is also traced distinctly, in the ♀ heavily, with a transverse, oblique black streak, followed in the ♀ and often in the ♂ by a blackish triangular cloud, reaching fully half way to the outer blackish bordering; outer margin of the wing broadly and pretty uniformly bordered, to about the width of an interspace in the ♂, to half as much more in the ♀, with blackish; this bordering has a curved and not a crenulate interior margin, excepting sometimes in the ♀, and at the apex of the wing curves around to the tip of the costal nervure, where it terminates in a point; below, it is often broader in the ♀,

and extends, diminishing in width, to the middle of the inner margin (δ), or to the base, occupying the whole of the inner margin, as far as the submedian nervure (η); the extreme outer edge of the wing is darker than the border, and the fringe is dull tawny, paler in the lower fourth, sometimes largely infuscated in the upper half or three-fourths. *Hind wings* having the costal margin bordered, as far as the subcostal nervure, with blackish brown, in the η also occupying the upper half and the termination of the cell; outer margin bordered either rather narrowly, to less than half the width of an interspace (δ), or rather broadly to about the width of an interspace (η), with blackish brown; a similar bordering follows the inner margin as far as the submedian nervure, but is rendered inconspicuous next the nervure by a plentiful supply of long, tawny hairs; similar hairs are found next the base, where the wing would otherwise be somewhat infuscated; the apical portions of the nervules, and generally also the whole of them, are delicately traced in black. Fringe tawny, paler next the anal angle, sometimes faintly cut with dusky at the tips of the nervules.

Beneath, *fore wings* dull, slightly paler tawny, with a slight greenish tinge. Inner border broadly bordered with blackish fuliginous, as far as the middle of the cell in the basal half of the wing, to the submedian nervure only on the outer half; similarly the lower half of the outer border is sometimes more or less broadly margined; the oblique dash at the tip of the cell repeated as a delicate line. Fringe slightly paler than above, but otherwise similar. *Hind wings* rather dark greenish yellow, between the median and internal nervures tinged with orange. Fringe much as above.

Abdomen blackish, the sides heavily clothed with fulvous hairs, which obscure also most of the upper surface, beneath changing to yellowish. Upper organ of male appendages (37:11) smaller than in the other species, and differing from them in being stoutest in the middle instead of distally, tapering from almost the very base; it also arches less than they, and the hook is more clearly divided, though the two halves together continue the regular tapering of the centrum, and are pointed at tip and slightly hooked. Lateral arms consisting of an inferior plate, separate from the hook, depressed, curving slightly upward and tapering to a point, scarcely shorter than the hook. Clasp a little more than half as long again as broad, the lower process pretty broad and equal, a little incurved, directed about equally upward and backward, pointed at the tip a little above the upper level of the clasp; upper process scarcely more than a bluntly rounded angle of the clasp.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	14.	14.5	15.25	15.25	15.75	16.5
antennae.....	7.15	7.	7.5	7.	7.2	7.25
hind tibiae and tarsl..	7.15	7.4	7.5	7.25	7.5	7.5
fore tibiae and tarsl..	4.55	5.	5.	4.5	5.	5.

Described from 9 δ , 7 η .

Caterpillar. *Last stage.* Head oval, oblique, white, smooth, slightly bilobed; a black band about top and sides, a black, vertical streak on the middle of the face, and a short streak of same color on either side this last. Thoracic shield black, ending in a black dot on either side; body fusiform, color bluish white; a lunate black band on penultimate segment and anal plate; the surface thickly dotted with minute black tubercles. Length, 25 mm. (After Chapman.)

Chrysalis. "Narrow, greenish-white, the head-case blunt, black, tubercled and bristly, the last segment black." (Chapman.)

Distribution (30:2). This butterfly is found over the whole extent of the Carolinian fauna from Florida (Chapman) to Texas (Capt. Pope) and over the southern half of the Alleghanian fauna. The northernmost localities from which it has been reported are Albany, N.Y., (Lintner), Lansing, Mich. (Edwards), the township of Ohio, Ill. (Morrison),

Denison, Iowa (Allen) and the Yellowstone region and Montana (Edwards). Farther south it has not been taken west of eastern Kansas (Snow) and Nebraska (Dodge).

In New England it has only been taken in a few localities in rather scanty numbers—at Holyoke (Chase), Amherst and Mount Tom (Dimmock), Belchertown, Granby and Montague (Sprague) and Springfield, Mass. (Emery), at New Britain, Conn. (Dimmock), and in Rhode Island.

Life history. In the north there is but a single generation, but in the south it is probably double, perhaps triple brooded, and can hardly winter there as a chrysalis—rather as a caterpillar. In the north it seems to appear upon the wing early in July, occasionally by the very last of June, and to fly until the middle of August. Abbot reports the capture of a specimen in Georgia on the 2d August, probably corresponding to this single northern brood; but it was taken in considerable numbers in Apalachicola, Fla., by Dr. Chapman, as late as the 1st of October.

Abbot says it inhabits oak woods in Georgia, which Judge Chapman speaks of as the best collecting ground in Florida, but in Iowa Mr. Allen found it on the flowers of *Echinacea angustifolia* D. C., which grows on grassy knolls of the open prairie. Mr. F. H. Sprague found it in the Connecticut valley alighting in the roads near meadows and brooks; according to him it is "terribly shy" and difficult of capture, not allowing approach. Dr. Chapman finds the food plant of the caterpillar to be *Erianthus alopecuroides* Ell.—one of the Gramineae.

Desiderata. The number of broods of this insect in the south, and its general history both north and south are the points which most require investigation. We have no description of its earliest stages, nor have we any account of the flight, postures and habits of the imago—in short nearly every fact is desirable.

LIST OF ILLUSTRATIONS.—*ATRYTONE* LOGAN.

Imago.

- Pl. 17, fig. 17. Female, both surfaces.
19. Male, half of upper surface.

- Pl. 37, fig. 11. Male abdominal appendages.

General.

- Pl. 30, fig. 2. Distribution in North America.

ATRYTONE ZABULON.—The Mormon.

[Hobomok skipper (Harris); the Mormon (Scuddler); orange and brown skipper (Maynard)]

Pipilo ogeechensis Abb., Draw. Ins. Ga. 29, fig. 3; pl. 34, fig. 6; pl. F, fig. 17, pl. I, fig. 15, ined.Brit. Mus., vi: 91, figs. 133-134, ined (ca. 1890).
Hesperia zabulon Botsd.-LeC., Lép. Amér. sept., pl. 74, figs. 6-7 (1893).*Pamphila zabulon* Westw.-Hew., Gen. diurn. Lep., ii: 523 (1852);—Morr., Syn. Lep. N. A., 16 (1862);—Morr., Can. ent., v: 164 (1873);—Fern., Butt. Me., 96-97, figs. 33-34 (1884);—French, Butt. east. U. S., 393-395, figs. 82-83 (1886);—Meyn., Butt. N. E., 59-60, pl. 7, figs. 92, 92a, 92b (1886).*Atrytone zabulon* Scudd., Syst. rev. Amer. butt., 56 (1872); Butt., 182-183, figs. 8, 30, 154 (1881).*Isotekton zabulon* Hew., Cat. coll. diurn. Lep., 228 (1870).*Hesperia hobomok* Morr., Syn. Lep. N. A., 110 (1862);—Saund., Can. ent., i: 66 (1869);—Pack., Guide Ins., 269-270 (1869).

Figured also by Glover, Ill. N. A. Lep., pl.

ATRYTONE ZABULON ZABULON.

The syngene female.

Hesperia zabulon Botsd.-LeC., loc. cit.*Hesperia hobomok* Harr., Ins. Inj. veg., 3d ed., 313-314, fig. 137 (1862).

ATRYTONE ZABULON POCAHONTAS.

The melanic female.

Hesperia pocahontas Scudd., Proc., Ess. inst., iii: 171-172 (1863);—Strecker, Lep., [7] (1872).*Hesperia quadraginta* Scudd., Proc. Bost. soc. nat. hist., xi: 381 (1868).*Pamphila quadraginta* Kirby, Syn. cat. Lep., 603 (1871).

Figured also by Glover, Ill. N. A. Lep., pl. G, fig. 15, ined.

Deft wings, each moment is resigned
 Some touch of day, some pulse of light,
 While yet in poised, delicious curve,
 Ecstatic doublings down the wind,
 Light dash and dip and sidelong swerve,
 You try each dainty trick of flight.

DOWDEN.

Abide me, if thou darest; for well I wot
 Thou runn'st before me, shifting every place,
 And dar'st not stand, nor look me in the face.
 Where art thou now!

SHAKESPEARE.—*Midsummer-Night's Dream*.

Imago (10:8-10; 13:11). Head covered with olivaceo-tawny hairs, mingled with fewer black ones, behind and beneath the eye are a few tawny yellow scales, with a few intermingled dusky ones beneath; at the outer base of the antennae a tuft of black bristles. Palpi rather pale lemon yellow, becoming paler toward the base, with infrequent, slightly longer, black, bristly hairs, intermingled throughout all the denser part, especially conspicuous from above; the apical joint furnished only with appressed black hairs. Antennae blackish brown on the upper outer part of the stem, deepening into purplish black on the thicker portion of the club above, elsewhere on the stem very pale, slightly lemon yellow, shading into tawny next the black, from which it is separated by a zigzag line, composed on each joint of an oblique line running from the inner side at the tip nearly to the middle of the upper surface at the base; apical half of club pale castaneous beneath, clothed only with short pile, the apical joint dusky; crook dark brown where the club is black. Tongue castaneous, very dark next the base, becoming luteous on apical third.

Thorax covered with dull olivaceo-tawny hairs above, beneath with mingled ruddy brown and dark greenish yellow hairs; legs covered with tawny yellow scales, becoming paler on the tarsi, mingled at the base of the femora beneath with many dark fuliginous ones, and marked along the middle of the upper surface of the tibiae and tarsi with a line of dusky brown scales, deepening and widening on the tarsi; leaf-like appendage of fore tibiae glossy brown; spurs very pale yellow, minutely tipped with testaceous, spines testaceous; claws a little darker; pad dusky.

Wings above tawny, broadly bordered with blackish brown. *Fore wings* with the costal edge brown, the base of the wing more or less largely obscured by brown or dusky scales, extending particularly along the nervures; in the male it is usually less deeply obscured than in the ♀, and ordinarily extends to the first divarication of the median nervure, while in the ♀ it often extends, especially above the subcostal nervure and below the first median nervure, nearly halfway to the outer margin of the wing; the outer dark border is also usually broader in the ♀ than in the ♂, averaging one and a half interspaces in width in the ♂, two in the ♀; its inner limit, which is irregularly crenulate, its convexities in the interspaces, commences on the third superior subcostal nervule just before its tip, and crosses three interspaces at right angles to the costal border; it traverses the next two interspaces midway between its former path and the outer margin, after which it returns nearly to its former direction, continuing nearly parallel to the outer border to the submedian nervule; the inner border, as far as the submedian nervure, is also brown, excepting a slender streak of obscure tawny sometimes found extending from the base to about the middle of the interspace; in the tawny area thus circumscribed the nervules are traced in brown and next the outer border, above the median area, the color is usually paler, making a series of little spots, rendered much more conspicuous because, usually in the female and not infrequently in the male, the dusky tracings of the base of the superior subcostal nervules become blended into a cloudy spot, and the interspaces beyond the cell are filled nearly to the dark margin with a longitudinal, oval or quadrate, dusky patch, usually less distinct and sometimes quite obsolete next the outer limit of the cell; the latter marked by a slender, blackish line. Fringe dark castaneous brown, merging into tawny below the lower median nervule. *Hind wings* very broadly margined with brown, leaving a central patch of tawny, crossed by the brown nervules and occupying the basal two-thirds of the lower subcostal interspace, the apical half of the cell, the subcosto-median interspace to within an interspace's width of the border and the basal two-thirds of the median interspaces; in the ♀ it is often still further diminished; the inner dark border is enlivened by a profusion of long, obscure, tawny hairs. Fringe tawny, more or less obscured above the lower median nervule, and especially at the nervule tips, with dusky.

Beneath: *Fore wings* tawny as above, but with more of a yellowish tinge, especially toward the inner margin; base more deeply, but less extensively, suffused with blackish, wanting above the subcostal nervure; outer margin bordered as above as far as the lower median nervule, below which it is largely infringed upon by the yellowish tawny, which beclouds it; the border is not so dark as above, and has a reddish tinge and is besides besprinkled with hoary scales on its outer half, through which the outer edge of the wing is marked by a dusky line, with a dot at the tip of the nervules; the inner border is margined with blackish, usually only on the basal half; the black, transverse, bent streak at the tip of the cell is repeated and occasionally the other darker markings of the apical half in an obscure manner; the median nervules, and occasionally the others, are faintly traced in brownish. Fringe glossy, rather pale castaneous, shading into dull tawny below, often dashed above with hoary and cut at the principal nervure tips with a dusky line. *Hind wings* dark brown, with a reddish tinge caused by cinnameous scales and hairs on a dark brown ground; next the outer margin rather broadly flecked with hoary, and across the middle of the outer two-thirds of the wing an exceedingly broad band of rather bright, pale greenish yellow—in old specimens quite pale—broadest in the subcosto-median interspace, narrowing a little only toward the costal, but considerably toward the inner border where it barely reaches the submedian nervure; its outer limit crosses the costo-subcostal and subcostal interspaces at more than an interspace's distance from the outer border; at the lower subcostal nervule it is removed more than half the distance toward the outer border, half of which it recovers at the upper median nervule, from whence it passes in a succession of crenulations to the middle of the outer half of the submedian nervure; the band is here the width of an interspace, and, returning, its interior margin is directed toward the middle median nervule just beyond its origin, to which it then runs, and crosses to the costal margin

midway between its basal band and the tip of the costal nervure; in the basal two-thirds of that portion of the subcosto-median interspace which is occupied by the band, it is often flecked with tawny and its interior margin is generally obscured on the upper half of the wing by a mottling of yellowish and brownish, indicated in some specimens by only a small, round, yellowish spot in the centre of the brown basal portion of the costo-subcostal interspace; the costal margin is often narrowly and distantly flecked with hoary, and the inner border is broadly and rather feebly flecked with yellowish hoary. Fringe very dull, brownish, honey yellow, brightest apically, with a faint, dusky, median belt.

Abdomen above blackish, profusely covered with tawny and olivaceo-tawny hairs; beneath dark brown, mostly obscured by abundant gray and pale brown, elongated scales. Upper organ of male appendages (37:17, 18) very strongly arched, the heavier part beyond the middle, where it is bulbous, tapering regularly and surmounted in the middle by a tapering, slightly curving tuft of reversed bristles. Hooks clearly distinct, but attingent, short, straight, needle-like, as long as half the extreme breadth of the centrum, scarcely incurved at the tip; lateral arms inconspicuous, aculiform, lying beneath the hooks. Clasps a little less than twice as long as broad, the upper angle produced slightly so as to be a little less than a right angle, and covering the lower appendage, which turns upward so abruptly that its lower edge forms the posterior, rounded border of the clasp which is turned back inwardly, and bears a sharp, triangular, upturned tooth, smaller and sharper than, but otherwise similar to, that which terminates the process, just above the upper edge of the clasp.

Measurements in millimetres. Length of tongue, 16.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	14.	15.	16.5	15.5	17.25	18.
antennae.....	7.4	7.75	8.7	7.4	8.25	8.5
hind tibiae and tarsi...	4.75	5.25	6.	5.	5.75	5.5
fore tibiae and tarsi...	7.5	7.8	8.75	7.4	8.25	8.25

Described from 120 specimens, of which 74 ♂, 34 ♀.

Dimorphic form. The dark female, ATRYTONE ZABULON POCAHONTAS (10:9), was first described as a distinct species. It may be distinguished as follows:—

Head covered with almost equally mingled black and dark tawny hairs; eye narrowly encircled behind with white scales, which become yellowish above and are interrupted with blackish brown ones beneath; palpi as viewed from above resembling the top of the head, the last joint covered with black hairs; beneath, the palpi have a hoary appearance, being made up of white scales, mingled more and more toward the tip with tawny and black scales and furnished scantily throughout with long black hairs. Antennae as in the normal type, excepting that the paler colors of the stem are replaced with white, which also interrupts the black slightly just before the club.

Thorax covered with black scales and long dark glaucous hairs, the wing covers and prothorax with intermingled black and dark tawny hairs; beneath with mingled brownish tawny, grayish and dull tawny hairs. Femora covered with dark silvery scales, blackish brown on the under and inner surface, fringed with silvery gray and blackish hairs; tibiae and tarsi dull white, excepting above, where they are brown, mingled with fulvous, the hind tarsi wholly dirty white; appendages as in the normal form, excepting that the spurs are dirty white, luteous tipped.

Wings above, dark chocolate brown; fore wings with a transverse series of four longitudinal, white, occasionally more or less deeply tawny spots at the base of the upper subcostal interspaces, the uppermost much smaller than the others, often reduced to a mere dot or obsolete altogether, lying just within the others, which are equal, arranged in a series at right angles to the costal margin; below them a slightly curving row of four similarly colored spots, the lower two sometimes dulled, lying nearly in a line connecting the apex of the wing with the middle of the inner margin, the lower two occupying the median interspaces much larger than the others, sub-quadrate, the lower the larger, the upper two in the interspaces above square and

equal when of full size, sometimes reduced nearly to dots. Just before the tip of the cell there is usually a double spot, the lower part smaller and sometimes obsolete; and in the medio-submedian interspace, below the lower median spot, there is a pale clouding which sometimes is developed to a double spot, the lower portion extending further toward the base than the upper. Fringe brownish olivaceous, with dusky lines running through it, not so dark below. *Hind wings* with the markings of the normal type reproduced with a greater or less degree of faintness by scattered, dull, tawny scales on a brownish base, slightly paler than the ground color of the wing. Fringe as in fore wings.

Beneath, *fore wings* brown, blackish toward the base, the middle of the wing more or less largely suffused with brownish yellow; the whitish or yellowish spots of the upper surface are repeated, those of the lower median and medio-submedian interspaces usually merged into a large, common, irregular, pale patch; above the middle median nervule the outer margin is besprinkled with pale bluish or hoary scales; the transverse black streak at the tip of the cell is indistinctly present. *Hind wings* very dark, chocolate brown, the band of the normal type present only as a slightly lighter field often sparsely besprinkled with a few very pale blue, elongate scales, such as give a hoary appearance to the apical half of the outer border, beyond the great transverse belt. Fringe of both fore and hind wings much as above, but slightly paler. Described from thirty-one specimens.

Egg (66:18). Surface of cells each with from 15-25 very minute punctuations; average cells measuring .0085 by .0127 mm.; extremes of micropyllic canals distant .004 mm. from each other. Cells bordering them (69:10) .0047 by .0094 mm.; outer cells of micropyle from .0113 to .0132 mm. in diameter. Color pale green. Height, .74 mm.; width, .95 mm.

Edwards is altogether mistaken in saying (Can. ent., xvi:110) that this egg is ribbed like a melon.

Caterpillar. *First stage.* Head (80:54) black, shining, smooth, with pale hairs .08 mm. long. Infrequent, inserted in shallow punctures; ocelli and mouth parts black; basal joint of antennae pale, third dusky, last pale; palpi pale fuscous; antennal bristle apparently arising from near tip of dusky joint, .14 mm. long. Body pallid, posteriorly tinged with lemon yellow; hairs pale, slightly fuscous at tip, not tapering and scarcely swollen at the tip, vertical, .08 mm. long. The last segment contains two pairs of long, recurved, bristly, subdorsal hairs .37 mm. long, and in addition along the hinder edge four others, directed backward but not nearly so long; first thoracic segment with a narrow, black, shining shield, .045 mm. in breadth, situated on the anterior portion of the segment, bearing, anteriorly at least, six hairs in a row, posteriorly two lateral ones; there are two colorless papillae, one above the other, in the middle of the sides of the second and third thoracic segments; spiracles concolorous; legs and prolegs white, claws slightly fuscous. Length, 2.82 mm.; breadth of head, .57 mm.; of body, .42 mm.

Second stage. Head smoky castaneous, the posterior rim and ocellar field piceous, minutely scabrous, hairs pale. Mouth parts testaceous, the edge of the mandibles black. Body grass green above, much paler below, the last three or four segments tinged above with pale brown; sprinkled rather profusely with dusky raised points, each bearing a short blackish hair, not so long as the shortest of the setae on which the segments are divided; first segment livid; the thoracic shield brownish piceous; legs and prolegs of the pale green color of the under surface; spiracles forming luteous, circular annuli; there is a pale dorsal stripe, in the middle of which the darker dorsal vessel can be seen in action; skin very transparent, allowing internal organs to be seen. Length, 7 mm.; breadth, 1 mm.; of head, .75 mm.

Third stage. Head varying from brownish red or ferruginous to a very dark blackish green, minutely scabrous; mouth parts dark ferruginous, the mandibles edged with black; ocelli blackish; antennae pale reddish. Body mottled in about equal measure with dark grassy green and pale dull yellowish, darker in the middle of the body, very faintly tinged posteriorly with reddish; specked profusely with black or blackish

green dots, each giving rise to a very short hair, so that the body appears covered with a close, delicate, short, uniform, whitish pile; the dorsal shield of the first thoracic segment inconspicuous, edged narrowly in front and behind with blackish fuscous; the dorsal vessel shows as a dark green line; there is also a narrow, pale, lateral line no wider than the dorsal vessel, broadly bordered with darker green, sometimes very inconspicuous; the under surface of the body, the lower portions of the sides of the thoracic segments, the first thoracic segment in front of the shield, and legs and prolegs pale green; the claws of the legs infuscated; stigmata pale testaceous, connected by a straight, narrow, pale, stigmatal line. Length 14.5 mm.; breadth, 1.75 mm.

Fourth stage. Head (80:55) dark ferruginous, obscured with black, especially at sides and across the front; lower parts and antennae paler; mandibles reddish; other mouth parts, seen from below, pale green; ocelli black. Body including terminal segment dark green, the latter with no blackish spots; first thoracic segment in front very pale green; segment edged posteriorly with a narrow, blackish, transverse, unbroken shield; stigmata ivory white; legs pale green, claws a little infuscated.

Last stage (77:22). Head (80:56) nearly uniform dark yellowish brown or dull ferruginous, scabrous, with slight punctuations, which are fuscous at bottom and give rise to fine, short hairs like those upon the body but longer; the head is barely paler beneath, the collar dark fuscous, broken in the middle; the ocelli black; mouth parts of the color of the head. Body yellowish brown, tinged faintly, especially in front, with pale reddish roseate, covered profusely with pale brownish pile, arising from minute, blackish, sometimes pinkish purple papillae; a narrow, dark reddish fuscous, dorsal line and small reddish fuscous spots scattered abundantly over the body and obscurely arranged in both transverse and longitudinal streaks, especially forming a pair of inconspicuous, closely approximate, lateral lines on either side; the lower half of the sides of the body is slightly paler, tinged with greenish; first thoracic segment pale anteriorly, the rest pale greenish, slightly infuscated and posteriorly edged with a narrow, dark fuscous shield broken in the middle; the last segment dusky above, sprinkled above with reddish fuscous and black dots; spiracles pale testaceous with a fusco-luteous rim; legs pale green, tinged with ferruginous, claws slightly dusky; prolegs of the pale greenish color of the under surface of the body, obscured with pale reddish roseate. Length, 21 mm.; breadth of head, 3 mm.; of body, 4.5 mm.

Chrysalis. Of uniform livid hue, the head a little infuscated and the appendages in general covered with a whitish bloom. The whole body, excepting the appendages, covered with delicate, pale brown hairs of the same length as those of the caterpillar and similar to them in closeness and character, seated on dark brown specks; the hairs at the anterior extremity are much longer and stouter than those of the body and are collected into bunches slightly closer than those on other parts of the body, and situated on the darker parts, the lighter being altogether free of them, there being a bunch at the interior base of each antenna, one on the darker border of the eye and a few hairs at the base of either side of the tongue,—the hairs being all directed downward and forward; on the metathorax is a pair of small, central, subdorsal, dusky spots; another pair midway between the middle and the posterior edge; borders of eyes and prothorax dull plumbeous; the rest of the prothorax reddish brown, the surface transversely furrowed; free part of tongue luteous; spiracles edged with pale testaceous; cremaster yellowish brown. Both extremities of the chrysalis are much covered with silky floss of the cocoon adherent to the hairs. Length, 20 mm.; breadth, 4.75 mm.

Distribution (30:3). This butterfly is found throughout the whole extent of the Alleghanian fauna, westward to the great plains. It apparently follows the Alleghanies southward, for it is found in West Virginia (Edwards), the mountainous parts of North Carolina, and in probably the higher parts of Georgia, for there is a memorandum of a single specimen captured in Georgia by Abbot, and an individual from the same state is

preserved in the British Museum. It is found, however, rather abundantly within the Canadian fauna and, in most of the settled parts of Canada, is the commonest of the Hesperidae from Nova Scotia to Western Ontario. The northernmost localities from which it is known, passing from east westward, are Nova Scotia (Jones), Quebec (Bowles), Compton (Gosse), Montreal (Couper, Caulfield), Ottawa (Billings, Fletcher), Sudbury (Fletcher), Nepigon (Fletcher, Scudder), and Calgary (Geddes). In the west it has a wider latitudinal extension, from the last named point to Nebraska (Carpenter), Kansas (Snow), Colorado at Ute Pass and Englemann's Cañon (Snow), New Mexico (Snow), and Dallas, Texas (Boll). Butler gives it from Costa Rica, but certainly by mistaken identification.

Of course it is found throughout New England, in the southern parts of which it is exceedingly abundant; it is even common in such northern and elevated localities as Williamstown, Mass. (Scudder), Thornton (Faxon) and Plymouth, N. H. (Scudder), Norway (Smith) and Waterville, Me. (Hamlin); but there seems to be no record of its occurrence among the White Mountains, where, however, it presumably occurs.

The dark form of the female, *A. z. pocahontas*, never quite so abundant as the normal female, has a range of nearly equal extent; specimens are in the Museum of Comparative Zoology from Maryland, which seems to be its southern limit, and it is reported from London, Ontario (Saunders), Ottawa (Billings), and Montreal (Couper), but not from Quebec or Nova Scotia, nor has it been taken in the northern half of New England, except at Portland, Me. (Lyman)—or indeed north of $43^{\circ} 15'$ N. Lat.; apparently it increases in abundance southwardly.

Oviposition. Eggs are laid freely in confinement on grass. They hatch in from eleven to thirteen days.

Habits and food of the caterpillar. The caterpillar on escaping from the egg devours first the micropyle and in one instance, after eating it, the creature remained four days longer in the shell before making a larger hole; it is always a long while in making its exit, for, as another instance, may be mentioned one which, twenty-four hours after it had eaten a hole nearly as large as its head, was still in the egg though it had now devoured about two-thirds of it; another, which was observed to have merely taken three or four bites early one afternoon, on the next morning had only completed a hole as large as its head; in this last instance, however, every fragment of shell (or at least of the vertical walls) had disappeared in another hour.

The caterpillar feeds upon common grass, "stationing itself about the inside of the leaves near the joints, drawing portions of the leaves together with silken threads, forming a rude case in which it secretes itself. When placed on a strong ribbed blade, the edges of which it cannot bend, it spins

a few threads from rib to rib, and places itself behind the threads" (Saunders). This latter action is performed by carrying a thread repeatedly between the same points, each thread being drawn tightly and made a little shorter than the previous, until the edges are brought so near together that the caterpillar has only room to withdraw its head; similar bands are made at short intervals; the process is very slow and is carried on without cessation until completed; one of the little strands is composed of twenty or thirty threads. If at all disturbed, it at once makes a new nest, which, as it is always very slight, is no very difficult task; it is extremely deliberate in all its movements, remains quietly in its nest by day and ranges the neighborhood for food at night; when about to change its skin it forsakes its nest and crawling downward conceals itself, generally head downward, among the roots and stems of the plants; it also invariably leaves its nest to expel its excrement, being very cleanly in its habits like most other Hesperidae, in marked contrast to the caterpillars of some of the higher butterflies.

Pupation. When about to change to chrysalis, the caterpillar constructs a nest of growing grass blades, generally near the joints, similar to its former habitation; continuing its work, however, it closes up all the interstices and even the upper extremity of the nest (which previously, in the vertical nests it always makes, is invariably left open) with a fine web of whitish silk in which is rather profusely intermingled minute bunches of flossy silk of the same color—a barrier impenetrable to the sight. Within this vertical cocoon, the transformation soon takes place; so far as I have seen, no thoracic girt whatever is constructed and the crotchets of the cremaster are simply plunged into the silk at the bottom of the cocoon.

Life history. The insect is single brooded, at least in the northern half of its range, passing the winter sometimes as a mature caterpillar, sometimes as a chrysalis. The first butterflies make their advent in the latitude of Boston during the last week of May, usually about the 27th, but sometimes by the 22nd, in the White Mountains during the first week of June; in southern New England it appears nearly a week earlier than about Boston, the female, even, being sometimes taken as early as the middle of the month. In the early part of June it is exceedingly abundant, and the dark females usually appear about this time, although they may be occasionally seen as early as the normal type; by the middle of June most individuals captured at large about Boston will have abraded wings, and during the latter half of the month the insects diminish rapidly, sometimes disappearing entirely by the 25th, though they often remain on the wing until the end of the first week of July, or a trifle later.

In the northern parts of New England and in Canada it may usually be found even later than this; while on the other hand Abbot records the capture of a specimen in Georgia as early as April 26; whether this indicates

a second brood it is impossible to say without further data; but a correspondent mentions the occurrence of the species in the vicinity of Boston "early in August," and Mr. Allen captured a male in Iowa on the 12th of that month, showing either that occasional early chrysalids give forth their inmates the same year, or, what is far more probable—for the caterpillars are extremely lazy—some individuals are occasionally greatly belated. To return to our history:—The female begins to lay eggs early in June, being busiest about the middle of the month, and continues the operation until it disappears; the egg is hatched in about eleven to thirteen days; the caterpillar may be found throughout July and August, for it is not until September that it is full grown and passes into the chrysalis; some, indeed, are still feeding at the very end of September and then pass into hibernation without changing to chrysalis.

Habits of the butterfly. The butterflies may be found almost everywhere in the open country, apparently preferring meadows, and are very fond of the juices of flowers, *Asclepias tuberosa* having a great attraction for them. Mr. Allen says "this hesperian occurred in groves" in Iowa.

It is a brisk, active flyer, off at a bound with wave-like starts and then alighting as abruptly under your eye, as who should say "Here I am, what's up now?" It rarely rises to more than a couple of feet above the ground, but goes swaying vigorously up the road as you advance upon it.

When at complete rest, the body is raised high on the legs, the anterior extremity elevated at an angle of from 30° to 40° ; all the wings are pressed back to back, the costal margin of the hind wings reaching to the middle of the upper median interspace, while the antennae are extended laterally in a common line, the crooks directed backward and a little outward; when disturbed in this attitude, the butterfly moves one or both antennae backward and forward enquiringly, one quite independently of the other, through an arc of from 30° to 40° . When at ordinary rest, the wings are all held alike, a little divergent from the perpendicular, and the antennae, diverging at an angle of about 110° , are slightly deflected from the plane of the body. When walking, the antennae, seen from above, are perfectly straight and diverge at an angle of about 135° ; seen from the side, they are nearly on a plane with the body, but are a little curved, the convexity downward.

Desiderata. It would be well to direct enquiry toward the apparition of the dark form of the female of this species, to determine whether it is more abundant in the south than in the north and whether it usually appears later than the normal form of the female. Butterflies occurring in August should be examined to see whether they are old and belated or fresh and premature individuals. Has this any connection with the stage at which the winter is passed, and what is the rule with regard to this point? The periods in the southern part of its range may help on this point. Its northwestern distribution needs more careful study. No parasites are known.

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| <p><i>General.</i>
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<i>Egg.</i>
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69:10. Micropyle.
<i>Caterpillar.</i>
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80: 54-56. Front views of head in stages I, IV and V.</p> | <p><i>Imago.</i>
Pl. 10, fig. 8. A. z. zabulon, ♀, both surfaces.
9. A. z. pocahontas, ♀, both surfaces.
10. Male, both surfaces.
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HYLEPHILA BILLBERG.

Hylephila Billb., Enum. ins., 81 (1820).
Euthymus Scudd., Syst. rev. Amer. butt., 56 (1872).

Hesperia pars Auctorum.
Pamphila pars Auctorum.

Type.—*Hesperia phylaeus* Drury.

I saw him run after a gilded butterfly; and when he caught it, he let it go again; and after it again; and over and over he comes, and up again; caught it again; or whether his fall enraged him, or how 'twas, he did so set his teeth, and tear it; O, I warrant, how he maimed it!

SHAKESPEARE.—*Coriolanus*.

Imago (59:4). Head large, heavily clothed with moderately long hairs arranged obscurely in transverse masses; outside of the antennae a slightly spreading, appressed bunch of arcuate bristles, the lowest the longest, but not extending over more than one-fourth the contour of the eye. Front protuberant and bullate, ridged transversely below the middle throughout nearly the entire breadth, and so as to surpass greatly the front of the eyes; above the ridge it is slightly tumid; below the ridge, the slope is a little ridged again across the middle; the whole piece is much more than twice as broad as long, its inferior margin broadly and regularly rounded, reaching to the outer front edge of the antennae, separated from the vertex by a transverse, very slightly arcuate, shallow sulcation, its convexity forward, terminating on either side at the middle of the antennae. Vertex slightly tumid longitudinally, scarcely tumid transversely, barely surpassing the eyes on the anterior, barely surpassed by the eyes on the posterior half, of the same length as the front, separated from the occiput by a slightly impressed, brace-shaped line; the latter deeply sulcated in the middle longitudinally. Eyes large, full, fullest in advance of the middle, nearly circular, naked. Antennae inserted with their hinder edges in the middle of the space included between the transverse ridge of the front and the back of the head, their interior edges separated by fully three times the diameter of the basal joints, the whole antenna plainly shorter than the abdomen, composed of thirty-two joints, of which sixteen form the club, which is less than one-third the length of the stalk, the crook consisting of but a single, minute, conical joint, half as long again as broad and less than one-third the length of the middle joints of the stalk; the club is stout oval, much more arched above than below, fully three times as long as broad, largest from the fifth to the eleventh joints, but increasing gradually in size from the base, and abruptly and broadly rounded at the tip. Middle joints of the stalk a little more than twice as long as broad, the third joint fully six times as long as broad. Palpi pretty short and very stout, the length not more than one and one-half times the diameter of the eye, clothed very compactly with a mass of long scales, beyond which the slender apical joint, clothed only with recumbent scales, projects rather conspicuously; basal joint small, bulbous, subpyriform, about as long as broad; middle joint very tumid, ovate, broadly and equally rounded at either extremity, nearly or quite straight, broader than the basal joint and nearly twice as long as broad; apical

joint slender, elongate, conical, bluntly pointed at tip, straight and at the base about one-eighth as broad as the middle joint and one-fourth as broad as long.

Prothoracic lobes not very large, appressed, laminate; viewed from the front triangular, each side a little convex, the upper outer side longest, inner side shortest, its extreme length nearly half as great again as its breadth and about three-fourths the shorter diameter of the eye. Patagia much slenderer than in the preceding genera, scarcely broader at base than the length of the prothoracic lobes, the posterior lobe less than half as broad as the base, more than half as long again, nearly four times as long as broad, straight, equal on the basal half, the apical half tapering a little to a rounded tip, the whole nearly as long as the breadth of the unusually broad head.

Fore wing (42:6) twice as long as broad; the lower outer angle falling directly beneath the middle of the wing; costal margin scarcely convex at base, beyond nearly straight; outer margin well and regularly rounded with slight indication of an excision at the first median nervule. Costal nervure terminating in the middle of the wing; subcostal nervure approximated to the costal margin, its nervules originating at longer distances apart than usual; the second arising before the middle of the wing; cell two-thirds the length of the wing, exceedingly slender, subequal in the distal two-thirds; the first median nervule arising midway between the base and the second, the second in the middle of the wing; internal nervure straight, short.

Hind wing of equal length and breadth; the costal margin beyond the strong basal lobe straight; outer margin between the costal and lowest median nervule strongly and regularly rounded; between the lower median and the internal as strongly rounded, forming a distinct lobe, its highest point below the tip of the submedian. Subcostal nervure forking much before the median; the median at a little beyond the basal third.

Discal stigma of male consisting of an oblique straight streak of dead black, closely compacted, erect scales crossing the base of the median interspaces, closely overhung in front by arching fulvous scales, except at extreme base, and followed below by a narrow area of erect, loosely compacted, changeable scales. The scales consist of jointed threads in the heart of the stigma, the joints unusually short, accompanied by subspatulate rod-like scales.

Legs 2, 8, 1; femora and tibiae clothed as in *Atrytone*, the superior tibial spines a little more conspicuous. Femora 2, 1, 3; tibiae 2, 3, 1; tarsi 2, 3, 1. Fore and hind femora two-thirds the length of the middle femora. Fore tibiae more than two-thirds the length of the fore femora, which are a little shorter than the hind tibiae, these scarcely shorter than the middle pair. Leaf-like appendage of fore tibiae lanceolate, a little curved, more than four times as long as broad, pointed, but tapering only toward the tip, originating in the middle of the outer four-fifths of the joint and not surpassing its tip; other tibiae furnished at the apex with a pair of very long and slender, tapering, unequal spurs and the hind pair with a similar shorter pair in the middle of the apical two-thirds of the tibia; the middle and hind tibiae are also furnished along the outer edge of the under surface, on which the spurs are shorter, with a row of infrequent very long and slender spines. Tarsal joints, 1, 2, 3, 4, 5, the penultimate possibly shorter than the terminal on the fore legs; fore tarsi more than two-thirds as long as the others, of the same length as the middle femora, all with a triple series of pretty long and slender spines beneath, the apical ones of each joint considerably longer than the others, excepting on the fore legs; basal joint as long as the second, third and fourth together, the second fully half as long as the first. Claws pretty small, slender, tapering, pretty strongly and regularly arcuate, finely pointed. Pad pretty large, cordiform; paronychii broad, ensiform, twice as long as broad, reaching nearly to the tip of the claws, compressed, laminate.

Abdominal appendages: Upper organ, large, broad, depressed, laminate, broadly arched; centrum and hook nearly similar and equal, the latter tapering, simple, blunt, extending beyond the clasp. Clasps rather small, triangular, broad at base, tapering, the tip bifid above.

Although consisting of but a single species, this genus is widely spread, extending from Virginia to Buenos Ayres. As will be seen below, it prop-

erly belongs further south than New England, but has been taken near its southern borders.

The butterfly is of small size, the male provided with a linear discal streak. The wings are tawny, above dashed longitudinally, and especially near the outer border, with dark brown, the female so much more heavily than the male as to form a connected border to the wings, and to give it rather the appearance of a dark butterfly dashed and spotted with tawny. Beneath they are paler, with two distant rows of dark dots on the outer half of the wings, indicating the borders of an irregular, transverse band.

The insect is at least double brooded, but how it winters is quite uncertain. The larva feeds on *Panicum*.

EXCURSUS LXVI.—SEASONAL DIMORPHISM.

Thou spark of life, that wavest wings of gold!
Thou songless wanderer mid the songful birds,
With nature's secrets in thy tints unrolled
Through gorgeous cipher, past the reach of words,
Yet dear to every child
In glad pursuit beguiled,
Living his unspooled days mid flowers and flocks and herds.
Thou winged blossom! liberated thing!
What secret tie binds thee to other flowers
Still held within the garden's fostering?
Will they, too, soar with the completed hours,
Take flight and be like thee
Irrevocably free,
Hovering at will o'er their parental bowers?
Or is thy lustre drawn from heavenly hues,
A sumptuous drifting fragment of the sky
Caught when the sunset its last glance imbues
With sudden splendor; and the treetops high
Grasp that swift blazoury,
Then lend those tints to thee—
On thee to float a few short hours, and die?
Birds have their nests; they rear their eager young
And flit on errands all the livelong day;
Each fieldmouse keeps the homestead whence it sprung;
But thou art nature's freeman;— free to stray
Unfettered through the wood,
Seeking thine airy food
The sweetness spiced on every blossomed spray.
The garden one wide banquet spreads for thee
O daintiest reveller of the joyous earth!
One drop of honey gives satiety,
A second draught would drug thee past all mirth.
Thy feast no orgy shows,
Thy calm eyes never close,
Thou soberest sprite to which the sun gives birth!
And yet the soul of man upon thy wings
Forever soars in aspiration; thou
His emblem of the new career that springs
When death's arrest bids all his spirit bow.
He seeks his hope in thee
Of immortality.
Symbol of life! me with such faith endow.

T. W. HIGGINSON.—*Ode to a Butterfly.*

IN an early excursus in this work, the general subject of dimorphism was discussed, without reference to that form of it which is termed seasonal, in which the phenomenon only appears on comparing individuals of different broods of the same year. It may, however, be ques-

tioned whether seasonal dimorphism should not have been discussed first, and whether it may not be the primal form of dimorphism in general, for I believe there is not a single instance in our fauna where dimorphism of any kind (excepting antigenic) occurs in a monogoneutic butterfly.

But however this may be, we have in not a few of our butterflies instances of seasonal dimorphism; indeed the successive broods of the same butterfly which appear in a single season almost always differ from each other; often so incredibly as to be mistaken for distinct species.

The imported cabbage butterfly is a case in point; the spring butterflies are smaller and of a duller white than the later broods, with broader black markings on the middle and tip of the wing, and the base sprinkled with black atoms, which are almost entirely wanting in the other broods; beneath, where the markings in this genus are most conspicuous and varied, there is a powdery streak of black scales along the middle of the hind wings, which, in the later broods, is much less conspicuous.

A somewhat similar distinction occurs in its near ally, the Gray-veined White. The summer brood of this species is almost pure white, while the spring brood, besides being smaller, has the under surface of the hind wings and of the tip of the fore wings heavily washed with yellow, and all the veins in the same area broadly sprinkled with dark scales. Moreover, in all the whites, the hind wings of the second generation are longer than those of the first.

In the American Copper, spring individuals are of a more fiery red, and the orange band of the under surface of the hind wings is broader; while in later broods the markings are less vivid and less distinctly marked, and there is a longer tooth on the margin of the hind wings.

In our Pearl Crescent, according to the discoveries of Mr. Edwards, the spring type (which he formerly considered a species distinct from the summer type, but which he has since bred from the latter) is characterized by the purple or pearly hue of the under surface of the hind wings, and by heavier markings on the same wings; especially by the presence of great patches of ferruginous or dusky color at the outer margin; markings which usually are only indicated in the summer broods, where the color is delicately traced with ferruginous lines; in the spring butterflies the black markings of the upper surface are also heavier and more diffuse than in the later broods.

A further instance, perhaps the most striking that we have, is in the often quoted case of *Iphiclides ajax*, whose changes have been so thoroughly worked out by Mr. Edwards. Here each form appears at a different season of the year; marcellus is the early spring type, telamonides the late spring, and ajax the summer and autumn type. Nearly all the butterflies which, in West Virginia, emerge from the chrysalis before the middle of April are marcellus; between that and the end of May, telamonides;

after this ajax. The first two, however, do not represent distinct broods; for telamonides is not the direct conseasonal produce of marcellus, but both are made up of butterflies which have wintered as chrysalids, those which disclose their inmates earliest producing marcellus, the others telamonides; while all butterflies produced from eggs of the same season, and there are several successive broods, belong to ajax. These forms differ in the length of the long tails upon the hind wings, in the clothing of the front of the head, in the extent of the blood-red spots upon the hind wings and in other markings, and before their relation was known were regarded by all naturalists as distinct species.

So, too, we have an admirable example in *Cyaniris pseudargiolus*. In New England, there first appears a blue butterfly, in which the spots of the under surface are very large and often blended into great patches. Later on, comes what is apparently another species, in which the spots of the under surface, still tolerably large and distinct, are never blended; and finally a third in which all the markings are very feeble and faint; so too, as the season advances the females grow paler and paler.

These forms of seasonal dimorphism and polymorphism have attracted the greatest attention of naturalists, and an explanation has long been sought of the causes which have induced them. Numerous experiments have been made which have brought to light the great probability that in some way the retardation of development through cold has had much to do with these changes. The argument in favor of this view is very much strengthened when we recall the fact stated at the outset, a fact which does not seem to have been particularly noted, that, although seasonal dimorphism appears between the earliest and later broods of the season without always affecting all the members of each, and although it appears to be wholly independent of whether the winter is passed in the imago, the chrysalis or the larval stage, it is nevertheless true that no case of any kind of dimorphism which affects alike both sexes has yet been noted, in which the species is single brooded. In support of this statement no instance in our own country can be more striking than that of *Polygonia*, all the species which are double brooded showing this form of dimorphism between the two broods, while no sign of the same appears in the species of which there is a single brood in the course of the year.

There would seem therefore, to be ground for believing that temperature has much or all to do with seasonal dimorphism; and the manufacture, so to speak, of the spring type from chrysalids which should normally produce the summer type (by the artificial application of cold) lends strength to this supposition, at least as regards seasonal dimorphism in the temperate zones, where the contrasts of temperature are great. And on this account Pryer and some others have chosen to denominate the resulting varieties as "temperature forms."

But the same phenomenon appears in the tropics, where there are no such extreme excesses of temperature; thus Semper tells us that the broods of Manila butterflies appearing between December and March are light colored and those from June to September are dark colored. Several years ago de Nicéville of Calcutta sent for exhibition to the Entomological society of London several series of Indian butterflies, which had been universally regarded as distinct species, but which closely resembled one another, excepting that the conspicuous ocellated spots of the under surface of the wings of certain kinds known only in the rainy season were replaced in other kinds which fly only in the dry season by more uniform, paler, and leaf-like markings, in which the ocelli are obsolete. He regarded these as probable instances of seasonal dimorphism,—a view which was vigorously combated by some of the members present at the exhibition. But he has since proved his right to the belief in several cases, having raised one series of forms from eggs of the other; de Nicéville believes that the obliteration of the ocelli is “an advantage to the insects during the cold and hot seasons, as at those times the vegetation is much more scanty and dried up, the insects live chiefly among the grass, and would consequently be easily seen were they not inconspicuously colored and marked; while in the rains, the vegetation being then very dense, they can hide themselves, and their conspicuous livery is no bar to their safety.” The species in which the seasonal dimorphism was proved were all *Satyrinae*, but de Nicéville adds that he could indicate “many dozens of Indian species” in which he believes seasonal dimorphism occurs, “including nearly every family into which butterflies have been divided,” but he “might again be accused of ‘guessing.’” These facts show that we have still a great deal to learn about seasonal dimorphism before we can speak confidently of its cause.

HYLEPHILA PHYLAEUS.—The fiery skipper.

[The bordered skipper (Haworth); the great headed skipper (Stephens).]

Hesperia phylaeus Drury, Ill. nat. hist., 1: 25-26, pl. 13, figs. 4-5 (1770);—God., Encycl. méth., ix: 723, 767-768 (1819);—Boisd.-LeC., Léop. Amér. sept., pl. 78 (1838);—Burm., Descr. phys. Rép. Arg., v: 243-249 (1875).

Hylephila phylaeus Billb., Enum. ins., 81 (1820).

Pamphila phylaeus Westw.-Hew., Gen. diurn. Lep., ii: 522 (1852);—Butl., Cat. Fabr. Lep., 276-277 (1860);—Chapm., Can. ent., xi: 190 (1879);—Gundl., Ent. Cub., i: 150-151 (1881);—French, Butt. east. U. S., 313-314 (1886).

Euthymus phylaeus Scudd., Syst. rev. Amer. butt., 56 (1872).

Isoteinon phylaeus Hew., Cat. coll. diurn. Lep., 227 (1879).

Papilio phareus Panz., Drur. Abbild., 50-60, pl. 13, figs. 4-5 (1785).

Papilio colon Fabr., syst. ent., 531 (1775);—Abb., Draw. ins. Ga. Brit. Mus., vi: 92, figs. 135-137 (ca. 1800).

Hesperia colon Fabr., Entom. syst., iii: 327 (1793).

Hesperia vitellius Fabr., Entom. syst., iii: 327 (1793).

Papilio vitellius Haw., Trans. ent. soc. Lond., i: 334 (1812).

Phemiades augias Hubn., Zutr. exot.

schmett., II: 10-11, figs. 227-228 (1822).

Pamphila bucephalus Steph., Ill. Brit. ent.,
Haust., I: 102-103, pl. 10, figs. 1-2 (1828);—
Humph.-West., Brit. butt., 126-127, pl. 40, figs.
1-3 (1841).

Figured also by Glover, Ill. N. A. Lep., pl.
B, fig. 18 (2 figs.); pl. F, figs. 26, 27; pl. N, fig.
1, ined.

Not *Papilio bucephalus* Wood.

Nun flatter er zu rosen
Von rosen zu den nessen
Von nessen zu den bäumen
Von bäumen zu der erde
Und bleibet nirgends sitzen.

DENIS.

Imago (17: 10, 13). Head covered above with pale tawny hairs, sometimes with a few blackish ones intermingled with them, but inconspicuously; even the tufts on the inner and outer side of the base of the antennae are composed of tawny hairs, more or less dusky on a front view; scales below and encircling the back of the eye white, tinged with yellow, becoming tawny above; palpi yellowish, pale at base, growing pale tawny toward the tip, a single series of black bristles down the outer front edge of the middle joint; the upper surface of the apical joint blackish. Antennae black above throughout, excepting the crook of the club; beneath pale buff throughout, excepting beyond the middle of the club, which with the crook is naked and dusky orange. Tongue black, tinged in apical half with castaneous.

Thorax covered above with pale tawny hairs, having a slight greenish tinge, and posteriorly dulled with dusky tints; beneath pale, dirty buff. Legs buff-colored, femora with a dusky stripe on inside, a dusky tip; tibiae paler beneath; tarsi growing slightly darker toward the tip; leaf-like appendage of fore tibiae pale yellowish brown; spurs buff, tipped with reddish; spines reddish luteous; claws the same; pad dusky.

Wings above pale tawny. The *fore veins* have a peculiar dark brown bordering to the outer margin, consisting of a series of triangular patches (below) or longitudinal dashes (above) in each interspace, seated on the border and united only next the border; in some specimens they are wholly independent in the upper half of the wing, and in the ♀ they are more largely connected than in the ♂; their interior limits follow a regular curve from the middle of the outer two-fifths of the costal border to the middle of the outer two-thirds (♂) or four-fifths (♀) of the inner border, excepting, however, in the interspaces beyond the tip of the cell, where they suddenly retreat toward the border making the spots no longer than broad; the veins closing the extremity of the cell are rather broadly flecked with dark brown, which scarcely reaches the median nervules, but is accompanied by and connected with a long longitudinal dash in the upper of the two interspaces beyond, reaching more than halfway to the border, and by a similar, also (generally) connected dash in the lower of the two interspaces, often as long as the upper, and then forming with it and the mark on the apex of the cell a single oblong patch, usually a little shorter but still connected, sometimes much shorter and detached; it is heavier in the ♀ than in the ♂, and is there connected at its tip above with the black bordering, and on its basal half above with a dark patch which runs to the costal margin, enclosing a small, circular, tawny spot outside of it and having an ill-defined interior border; the costal edge of the ♀ is also blackish; base of the wing more or less heavily obscured, more heavily in the ♀ than in the ♂, with dark brown scales, which usually follow the subcostal, median and submedian veins for a distance about equal to the width of the base of the wing in the ♂, but in the ♀ are more diffused and are accompanied also by a longitudinal dusky streak in the middle of the cell, and a large, dark, longitudinal, subquadrate patch as broad as the width of the cell, occupying the place of the ♂ dash, limited above by the median nervure, its upper outer angle touching the lower inner angle of the spot at tip of the cell, its interior border ill-defined and reaching more than halfway toward the base. The ♂ dash (43:4) is velvety black, reaches from the last divarication of the median to the basal two-thirds of the submedian nervure, and is composed of two equal, partially overlapping, straight, ovate or fusiform patches, the outer scarcely higher than the inner, each about four times as long as broad, together forming a scarcely sinuous

dash; it is accompanied beneath by a more or less distinct, clouded patch, shorter but broader than itself, with a rounded border and composed of partially erect, segregated scales, changable, metallic green and purple by reflected light; the outer edge is marked narrowly with blackish, and the fringe is pale or whitish fulvous, tinged with brownish, especially in the ♀, and on the basal portion above the lower median nervule. *Hind wings* with an outer border similar in character to that of the fore wings, increasing regularly in width in either direction from the subcosto-median interspace, where it is less than an interspace in width, to the medio-submedian interspace, where it reaches more than one-fourth way to the base of the wing; the whole costal margin is also bordered with dark brown as far as the subcostal nervule and in the middle of the wing, even broadening so as to include the base of the subcostal interspace and the very extremity of the cell; the inner margin is similarly bordered as far as the submedian nervule, but is largely obscured by tawny hairs, as is also an obscure, dusky spot, often absent from the ♂, but always present in the ♀, occupying the bases of the median and medio-submedian interspaces, and in the ♀ reducing the tawny marks to a pretty broad, equal, tawny band, which sends a slender streak baseward in the cell and is broken by the nervures slenderly traced in brown. Fringe as in fore wings, but paler.

Beneath pretty uniform, brownish yellow, approaching buff. *Fore wings* with the basal portions only of the marginal spots present and in diminished intensity and size, forming a series of independent, triangular, submarginal spots, those of the interspaces beyond the cell often obsolete; the oblique streak marking the tip of the cell is also present and is sometimes accompanied—notably in the ♀—by the dashes beyond it, but much obscured; the lower half of the base of the wing as far as opposite the middle of the cell, the inner margin as far as the submedian nervule, and the ♂ dash, or its corresponding spot in the ♀, are blackish fuscous; between the last mentioned markings and the submarginal spots, especially on the lower half of the wing, the brighter colors become paler, occasionally and particularly in the ♀ somewhat livid; the outer margin is delicately traced in blackish, and the fringe resembles that of the upper surface. *Hind wings* with a submarginal bent series of independent, small, dusky, occasionally sagittate spots, corresponding to the apices of the marginal spots of the upper surface, and varying in size and intensity; there is also a frequently obsolete series of similar, but generally when present, smaller and more obscure spots in the same interspaces, parallel to the submarginal row and crossing the middle of the wing; between the two series the wing is frequently a very little paler, occasionally very much so, especially when the whole wing excepting the transverse belt thus formed is tinged, as it occasionally is, especially in the ♀, with a greenish brown hue; there is, also, a small dark spot at the extreme base of the subcosto-median interspace, and sometimes another, usually larger, and occasionally forming a longitudinal dash, in the centre of the cell; the outer margin above the lowest median nervule is very delicately traced with dark brown, and the fringe is pale fulvous, in the ♀ tinged with brownish.

Abdomen profusely furnished above and on sides with tawny hairs, beneath pale buff. Upper organ of male appendages (37:13) with the centrum broadly channeled above, from the thickening of the edges; hook fully two-thirds the length of the centrum, a little longer than broad, docked at the tip, a little longitudinally channeled above, the upper edges minutely denticulate, with a larger tooth next the base, below which the lateral arms appear as a slight expansion. Clasps less than twice as long as broad, only reaching the lateral arms of the upper organ, pretty regularly triangular, terminated above by two similar, equal, cylindrical, blunt-tipped fingers, directed backward and slightly upward, attingent, their length equalling half the breadth of the hook.

Measurements in millimetres. Length of tongue, 11.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	13.5	15.	15.5	16.		16.5
antennae.....	5.5	5.75	6.	5.		5.5
hind tibiae and tarsi.....	7.25		8.			
fore tibiae and tarsi.....	5.25	5.15	5.8	4.5		5.5

Described from 21 ♂, 2 ♀.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wings; the scales contained in it consist of jointed threads, the joints remarkably short and oval (48:6 d), accompanied, especially toward the base, by spatulate or subspatulate scales, or rod-like scales (6 c, e), the stigma guarded at the base by faintly two-pronged, rod-like scales (6 b); while in the field below the stigma the scales are long, ovate, with excised outer margin (6 a).

Caterpillar. *Last stage* (77:19). Head reddish castaneous, with a pair of subdorsal, white streaks, on the summit and the upper part of the triangle white. Body rather pale, grass green, profusely and delicately mottled with darker green, except in a stigmatal stripe; a narrow, dark green, dorsal line; beneath the stigmata darker green, with a faint yellowish, substigmatal stripe; the first thoracic segment is pale green with a broad, central, transverse, black stripe reaching nearly to the stigmata; stigmata dark green; legs castaneous; prolegs green. Length, 35.5 mm.; width of head, 2.7 mm.; height of body, .5 mm. Described from Abbot's original.

Another description. Head small, smooth, but delicately punctuate, dark brown. Thoracic shield dark brown; body fusiform, of a uniform, dull green, and thickly granulated with pale points. Length, 18 mm. (After Chapman.)

Chrysalis (85:39). Head and thorax dull green, some of the sutures narrowly dull pinkish; tongue reddish. Abdomen yellowish green, the spiracles and cremaster reddish. Length, 19 mm.; of cremaster, 1.75 mm.; height of thorax, 4.5 mm.; of abdomen beyond wing covers, 3.75 mm.; length of tongue beyond wing covers, 7.25 mm. Described from Abbot's original.

Another description. Nearly cylindrical; the head, thorax, and abdomen pubescent; color pale green; a black line, interrupted on the posterior segments, extends from back of head to last abdominal segment; a lateral black streak on the thorax and a lateral row of black spots on the abdomen; more or less punctured throughout; the wing cases paler, contracted behind into a subulate point; cremaster stout, spine-like. Length, 13 mm. (After Chapman.)

Distribution (30:4). This butterfly is an inhabitant of the southern as well as of the northern continent, occurring as far south as the Argentine Republic and even Patagonia (Berg) on the east and Peru (H. Edwards) on the west coast; it occurs in abundance in the Antilles and Central America, is found throughout the southern United States from Atlantic to Pacific and in the eastern half of the continent as far north as eastern Kansas (Snow), Illinois (Worthington), Atlantic City, N. J. (Aaron) and the vicinity of New York City.

The two last localities render it probable that it will be discovered somewhat further north along the sea coast and I believe it was taken years ago by Norton in Farmington, Conn.

It is hardly probable that this insect has ever been found in England, as alleged. It is the more improbable, since the male said to have been found there and figured by Wood has been regarded as the same species as the female figured by Stephens and by Westwood, which it is not. Probably a mistaken etiquette has been the source of all the confusion. The species figured by Wood is an *Erynnis*, that figured by the others the present species, a common insect liable to be sent to Europe from almost any of the warmer parts of America.

Life history. Almost nothing is known of its history. Dr. Palmer took poor specimens at Indian River, Florida, at the end of March, Abbot

records a capture in Georgia, May 15, Aaron says it is found in southern Texas in August, Palmer brought poor specimens from St. Johns River, Florida, taken August 18-19, Grote found fresh specimens in Alabama in the middle of September and Dr. Oemler sent me fresh specimens of both sexes from Wilmington Island, Georgia, taken the last of October and the middle of November. Perhaps then it winters as a butterfly and has two broods, one in the middle of May, and a larger one in the latter part of the year, or perhaps there are two at this season, one early in August and one toward the end of September.

Abbot states that the caterpillar feeds upon crabgrass, *Panicum sanguinale* Linn.

Desiderata. Until the history of this butterfly is known with some degree of precision and we have accurate accounts of its earlier stages, every fact is desirable.

LIST OF ILLUSTRATIONS.—*HYLEPHILA PHYLAEUS*.

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|---------------------------------------|--|
| <i>Caterpillar.</i> | 46:6. Neuration. |
| Pl. 77, fig. 19. Mature caterpillar. | 48:4. Discal stigma of fore wing of male. |
| <i>Chrysalis.</i> | 48:6. Scales of the discal stigma. |
| Pl. 86, fig. 39. Chrysalis. | 59:4. Side view of head and appendages. |
| <i>Imago.</i> | enlarged, with details of the structure of the legs. |
| Pl. 17, fig. 10. Male, both surfaces. | <i>General.</i> |
| 13. Female, half of upper surface. | Pl. 30, fig. 4. Distribution in North America. |
| 37:13. Male abdominal appendages. | |

ERYNNIS SCHRANK.

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| Erynnis Schrank, Fauna boica, II, 1: 157 (1801); | Hesperia pars Auctorum. |
| —Scudd., Proc. Amer. acad. sc., x: 167-168 | Augiades pars Auctorum. |
| (1875). | Ocytes Scudd., Syst. rev. Amer. butt., 55 |
| Pamphila pars Auctorum. | (1872). |

Type.—*Papilio comma* Linn.

'Tis the shadiest place when the blazing sun flings
His straight rays on the rose and the butterfly's wings.
ELIZA COOK.—*The Room of the Household.*

Imago (58:8; 59:8). Head large, heavily clothed with moderately long hairs arranged in transverse masses; outside of the antennae, a spreading, appressed bunch of arcuate bristles, extending about one-third way around the eye. Front protuberant and tumid, wholly surpassing the front of the eyes, most tumid just below the middle and in the middle of each lateral half, sloping off gradually on all sides; a very slight median longitudinal sulcation; the whole piece is considerably more than twice as broad as long, and the front border, which is marginate, is sometimes slightly excised in the middle and broadly rounded on either side, terminating at the outer front of the antennae; it is separated from the vertex by a distinct but shallow, straight sulcation, which strikes the antennae just in advance of the middle of their bases. Vertex slightly arched longitudinally, and almost wholly flat transversely, just reaching or scarcely surpassing the level of the eyes in the anterior higher half, of the same length as the front, and separated from the occiput by two slightly arcuate, scarcely impressed lines, inclining a little so as to form in the middle a very broad angle. Eyes large, pretty full, nearly circular, naked. Antennae inserted in the middle of the summit, their interior edges separated by three times the diameter of the basal joints, the

whole antenna of the length or nearly of the length of the abdomen, composed of from thirty-three to thirty-five joints, of which sixteen to eighteen form the club, which is nearly half as long as the stalk, the crook consisting of from four to six minute joints; the latter tapers rapidly to a point and is but a little if any longer than half the greatest width of the club; this is stout, oval, a little compressed, largest in the middle of the outer three-fifths, or at about the tenth joint from the tip of the antennae, broadly rounded toward the crook, tapering gradually toward the base; middle joints of the stalk about three times longer than broad; third joint scarcely more than four times as long as broad. Palpi short and stout, about half as long again as the diameter of the eye, clothed very compactly with a mass of pretty long, slender scales, which the apical joint, clothed only with recumbent scales, scarcely surpasses; basal joint small, bullate, triquetral, largest at apex, where it is protuberant at the inner interior extremity, and to a less degree externally; middle joint large, bullate, regular, oblong oval, scarcely arcuate, broadly rounded at either extremity, but especially at the base, as long as the diameter of the eye, and about two and one-half times longer than broad; terminal joint minute, slender, equal, but bluntly pointed, straight, more than four times as long as broad, but scarcely longer than half the breadth of the middle joint.

Prothoracic lobes not very large, appressed laminate, oval, more than half as long again as high, more pointed at the exterior than the interior extremity, the length about three-fourths the diameter of the eye. Patagia moderately large, the posterior lobe not nearly half so broad as the base, fully as long, sometimes considerably longer than the base, equal, tapering very gently throughout, the apex rounded, the whole considerably shorter than the width of the head.

Fore wing (42:1,10) almost twice as long as broad, the lower outer angle falling scarcely beyond the middle of the costal margin; costal margin scarcely concave in the middle or slightly before it; outer margin gently and regularly convex, the apex distinctly produced, sometimes more distinctly in the male than in the female. Costal nervure terminating a little beyond the middle of the costal margin; subcostal nervure closely approximated to the costal margin, the second nervure arising at or scarcely beyond the middle of the wing; cell two-thirds as long as the wing, very slender, subequal in the apical three-fifths; first median nervure arising midway between the base and the second, the second at or scarcely beyond the middle of the wing; internal nervure straight, obscurely connected apically with the submedian.

Hind wing a very little longer than broad; the costal margin straight beyond the strong basal lobe; the outer margin variable but always well rounded, sometimes with a slight excision at the lower median nervure, so as to give a scarcely lobed appearance to the outer border below this, but always about equally prominent in the subcostal and submedian areas; the anal angle well rounded. The subcostal nervure forks before the median to a greater or less degree, the first median forking being tolerably regular, at no great distance from the second, which is at the centre of the wing.

Discal stigma of male (45:1) consisting of a gently arcuate streak, broadest basally, pointed apically, crossing the base of the median interspaces and composed of closely compacted, erect, dull black scales or rods, the lower edge supported and the middle more or less longitudinally interrupted by a thin row of large and broad, erect scales. The scales themselves consist of jointed threads in the heart of the stigma, in the first section consisting of short, fusiform joints, in the second of equal and slender joints; these are accompanied by spatulate rods in some instances, and guarded at the edges by two-pronged and three-pronged rods and elongated scales.

Legs 2, 3, 1. Under surface of femora and upper surface of tibiae clothed as in *Euthymus*. Femora 2, 1, 3; tibiae, 2, 3, 1, or 2, 3, 1, in the latter case the middle scarcely longer than the hind pair; tarsi 3, 2, 1, in the species which have the comparatively shorter middle tibiae approximately 3, 2, 1, so that the difference in the length of the middle and hind tibiae and tarsi together is more noticeable; fore femora scarcely longer than the hind, fully four-fifths the length of the middle pair. Fore tibiae two-thirds the length of the fore femora, three-fifths the length of the

middle tibiae. Leaf-like appendage of the fore tibiae, long and slender, lanceolate, originating in the middle of the outer four-fifths of the joint, but not surpassing its tip because strongly curved, about five times as long as broad, tapering apically to a pointed tip; other tibiae armed at tip with a pair of long and slender, unequal spines, the hind tibiae with a secondary similar, but slightly shorter pair in the middle of the apical two-thirds of the joint and both with a lateral row of infrequent, very long, prominent spines as in *Hylephila*. Tarsal joints 1, 2, 3, 4, 5 the apical joint sometimes slightly longer than the preceding in the fore legs. Fore tarsi scarcely less than five-sixths the length of the middle tarsi, nearly one-third longer than the middle tibiae—all with a triple row of frequent, small, delicate spines beneath, those at the apex of each joint, and especially of first joint, scarcely longer; basal joint as long as the rest together; second joint nearly or quite half as long as the basal. Claws pretty small, very delicate, tapering, strongly curving, or more nearly bent at the middle, finely pointed. Pad moderate, cordiform. Paronychial large and broad, compressed, laminate, fully as long as the claw, bluntly pointed at the tip, its upper border regularly and pretty strongly arcuate, its lower border strongly excised on the apical two-thirds. A pair of nearly straight, scarcely diverging, stiff bristles project beyond the claws, above, to about twice their length.

The seventh abdominal segment is terminal in a state of quietude in the female and passes but little beyond the sixth; it is composed of an upper, triangular side piece with a posterior, inferior, truncate extension, and of a larger, inferior plate composed of three median pieces, depressed, of equal width, ending in an angular apex and two thick, triangular, outer pieces placed a little below the others, covered with short pile, and ending posteriorly in a point; these form the anterior wall of the copulatory pouch, in the depth of which is a small, globular, pellucid, fleshy prominence, which supports a very slender, cylindrical, fleshy, pointed finger. These parts are here only seen under pressure. The eighth segment is formed above of a bent auricular, lateral thickened piece, those of opposite sides meeting above, covered with long and delicate erect hairs, and beneath this of a globular, tumid bag. Upper organ of male appendages pretty large and stout, strongly and regularly arched, somewhat depressed; centrum longitudinally sulcate above. Hook simple, rapidly tapering and depressed on basal half, beyond aculiform; lateral arms springing from the base of the hook, aculiform, as long as, and curving in an opposite direction to the hook. Clasps broad, subtriangular, tapering, a little convex, the extremity armed above with two up-turned, long, tapering and finely pointed teeth, the inner sometimes the smaller; end of clasps rounded.

Egg. Half as broad again as high, broadest at the base, narrowing regularly but very greatly on the basal two-thirds, above broadly and regularly rounded, scarcely flattened. Surface broken up by exceedingly slightly raised lines into pretty regular hexagonal cells. Micropyle consisting first of seven, compressed, oval, somewhat lozenge-shaped cells clustered irregularly around a common centre; other cells much larger, irregular, polygonal—usually pentagonal or hexagonal—somewhat kite-shaped, those nearer the centre being always at least twice as long as broad, the outer nearly as broad as long, increasing in size but not much in length from centre outwards.

Caterpillar at birth. Head globose, broad and subtruncate at base, as seen from in front, the upper two-thirds almost exactly semicircular in outline, sparsely punctate; triangle reaching above the middle of the head, considerably higher than broad, at the level of the ocelli with a transverse, arcuate series, convexity upward, of four minute hair-bearing papillae, the middle ones more widely separated than the others. Third joint of antennae about twice as long as broad, cylindrical but slightly arcuate, with a fine bristle much more than double its length. Body not very elongated, plump, slightly arched, falling off rapidly behind; dorsal shield of first thoracic segment moderately large, thickened at the edges, particularly on the front edge, the legs of this joint more corneous than the others; last segment with two pair of subdorsal papillae, giving rise to long, recurved, pointed hairs; other dermal appendages are seated on papillae, wine-glass shaped, the pedicel generally two or three times as long as the

apical expansion, the whole less than half as long as the segments, erect, excepting an uppermost row, in which they are inclined inwards; they are arranged on each segment as follows: a subdorsal series, placed one in the middle of the anterior half; a lateral series, one in the middle of the posterior half; a supra-stigmatal series, one a little in front of the middle; and an infra-stigmatal series, one anterior and one posterior; claws of prolegs arranged in oblique ovals.

Mature caterpillar. Head full, well rounded, broadest below and well arched above, the median suture but little sulcate; viewed laterally the head is of nearly equal depth on the lower half, gradually and slightly narrowing above, where it is also well rounded; triangle twice as high as broad, scarcely tapering in the lower half, its apex reaching considerably above the middle of the head. Head uniformly vermiculate throughout, and covered with very short, delicate pile. Second joint of antennae small, roundish; third but little slenderer, cylindrical, slightly larger at tip than at base, more than twice as long as broad; fourth very minute, similar in form to third. Ocelli six in number, five of them placed in a regularly but strongly curved series, its convexity downward and forward, the second and third counting from above in contiguity, the first distant from the third slightly more than the fourth from the third or fifth, the last opposite the base of the antennae, and at an equal distance from it and the fourth ocellus; sixth nearly on a line with the fifth and the antenna, and nearer to it than to any of the others; all the ocelli of nearly equal size, not very prominent, the upper quite flat. Labrum very small, more than twice as broad as long, but slightly and broadly excised in the middle of the front, which otherwise is well rounded. Mandibles pretty large and very stout and heavy. Labial palpi small, the joints of nearly equal length, and decreasing rapidly and regularly in stoutness. Spinneret small.

Body moderately plump, cylindrical, but tapering from the middle forwards, the second thoracic segment about as large as the head, the posterior half at least of each segment transversely wrinkled and the whole body covered with minute, raised points, irregularly distributed, and an infra-stigmatal series of minute, crateriform disks, situated centrally on the first to eighth abdominal segments, and a similar latero-stigmatal disk on the middle of the third thoracic segment, looking like a false spiracle; first thoracic segment with a rather slender, transverse, corneous shield, nearly uniting the front of the spiracles, scarcely parted at the dorsal line. Spiracles very small, the edge heavily ridged, obovate, twice as high as long, that of the first thoracic segment four times as large as the others. Legs rather short, slender, tapering, compressed, pretty heavily clothed beneath with short bristles; the claw small and slender; prolegs of moderate size, short, tapering rapidly, and armed with very small hooks.

This genus, tolerably rich in species, belongs to the north temperate zone and is almost exclusively confined to America, a single species only being found in the Old World. On both continents it extends from ocean to ocean. In the Old World, the single species known, *E. comma*, is found from Atlantic to Pacific between the 35th to the 60th degree of latitude and extends up the sides of the Alps to the height of 7,000 feet. The northernmost points from which it has been recorded are northern Scandinavia and Finland; and the southernmost Corsica, Syria and the Altai Mountains in Asia. In the New World, the genus reaches from Lat. 32° to 53° only, and no single species has any such range; most of them are species of high altitudes; only one species is common throughout New England; another is not uncommon in the southern portion, and the remaining two have in a few instances been found within its limits or

near by. The richness of this genus in America and its extreme poverty in the Old World lead to the presumption that the genus had its origin in our own country and that temperate North America is its proper metropolis. Moreover a northern variety (*caiena*) of the European species is found in eastern Labrador.

This genus may be considered the typical group of Pamphilidi. The butterflies are of small size but stout bodied; the fore wings of the male are furnished with a slightly curved, nearly linear, outwardly tapering, discal dash. The wings are tawny above, relieved by a broad or narrow border of dark brown, repeated very obscurely on the paler under surface.

As in *Atrytone*, one of the American species of this genus is peculiar in having dimorphic females, one of them being melanic and nearly devoid of any markings save a few small, angular, vitreous spots on the outer half of the fore wings. Here, too, this form has been described as a distinct species.

Our butterflies are single brooded, wintering in various ways. The European species is said by some to be single brooded, but Meyer Dür explicitly states that it is double brooded on the lowlands of Switzerland, although single brooded at the higher levels; the first generation disappearing by the middle of July and fresh individuals appearing in the same spots late in August.

In England, where it is single brooded, winter is passed in the egg-state, according to Hellins; but our eastern species, so far as known, probably all winter as chrysalids; one, at least, is one of the earliest of the Pamphilidi to appear on the wing, being seen by the middle of May. In the west, however, the species appear at several different periods of the year, so that there is probably considerable variety in this respect; and one, *E. jub.*, flies so late (September-October) that it probably winters in the egg.

The butterflies are rapid in flight and are abundant in grassy spots and meadows, loving the hottest rays of the sun. The caterpillars feed on grasses and the European species is said to feed also on Leguminosae (*Coronilla*, *Hippocrepis*, *Ornithopus*, *Lotus*). The metamorphoses of two or three of the species are known to a greater or less extent.

The eggs are pretty large, high and well arched, of a chalky white, with a thick shell hardly showing the reticulation with which it is covered.

The caterpillar at birth is white with a dark head and thoracic shield, a scarcely arched body, the fungiform appendages in three rows above the spiracles, at very different positions upon the segments, short and very much expanded apically. The full grown caterpillar is cylindrical but tapering from the middle forward, the head about as broad as the middle thoracic segment; the body is uniform in color, heavily flecked with numerous, irregularly disposed, raised points.

The chrysalis is elongated and cylindrical, but is insufficiently known. It is said to be thrown into the most violent contortions on the least disturbance and often to bend itself so as to make the front part of the body vertical.

EXCURSUS LXVII.—THE COSTAL FOLD AND DISCAL
STREAK OF SKIPPERS.

Yet let me flap this bug with gilded wings.

POPE.

HARDLY any special structures in our butterflies are more interesting than those which are peculiar to the male sex and probably serve as odoriferous chambers, though in some instances, where conspicuous, they may also serve as ornamental attractions.

In no family of butterflies are these more common than in the skippers, where the two tribes known in our fauna are almost always separable by the general nature of these presumably odoriferous chambers, one tribe, the Hesperidi, effectually secreting their androconia in the reflexed margin of the costa of the fore wings, the other, the Pamphilidi, making a conspicuous feature of theirs in the discal stigma of the upper surface of the same wings.

The costal fold of the Hesperidi (represented on pl. 45, figs. 2, 3) has been studied by Fritz Müller and by Aurivillius and is really a most remarkable structure; remarkable chiefly because here and only here in butterflies the marginal vein is developed to any appreciable degree; here it is as highly developed as any other vein, and the membrane between it and the costal vein being exceptionally broad it folds back upon the upper surface so as to lie next the costal vein; so that though the marginal vein is developed it does not practically form the margin, but, as in the female, that function is given to the membrane in front of the costal vein, here doubled upon itself. The purpose of this reflexion of the costal margin is to form an enclosure within which may be concealed the androconia, probably scent scales, whose odor is probably so delicate that it needs to be bottled up, as it were, within this concealment; and indeed the closure of the fold is so admirable that it is often difficult to tell whether or not there be a fold. Within this fold are several distinct sorts of scales, each having its own special field, and these are in general the same throughout the group; that is, each separate pavement or area bears its own peculiar scales which, though they vary to a considerable degree, even in species of the same genus, are nevertheless generally reducible to a single type, distinct from the others.

As regards concealment the sexual discal streak of the Pamphilidi is

quite another affair. It would seem as if attempt at something striking had been made. Many of these are figured on plates 43 and 45. They usually appear as patches or oblique dashes of peculiar scales covering veins and membrane indiscriminately, but usually, and in our native butterflies always, occupying the middle of the front wing, and crossing the median veins obliquely near their base. These dashes are variously formed, but the scales which compose the most striking external feature are much larger than the ordinary scales, are black, and frequently partially erect. They may also differ in various parts of the patch itself, and may alter their character abruptly; for instance, some comparatively huge and brilliant scales may occupy the middle line, and be buttressed by a multitude of minute, crowded, lustreless scales; or there may be at one point a sort of whirlpool of large party-colored scales, imbricated, in the most regular fashion, like the normal scales, and, beyond them again, a multitude of the minute, crowded, lustreless scales. These peculiarities, however, must be studied with a glass; the naked eye may indeed discern that the patch differs in different insects, but the general effect in all alike is a variously formed velvety patch or oblique streak of black.

Now, the object of all this, however important it may possibly be as an ornamental appendage, is primarily concealment for the androconia, which are quite out of sight, roofed in by the large imbricated scales of opposite sides, which it would seem the insect must have the power of parting to allow the scent to escape, just as the costal fold can be opened, flung open probably, by some muscular movement at the base of the wing. In this discal patch likewise there is a certain regular distribution of the special scales, and these have their characteristic types.

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Table of species of Erynnis, based on the egg.

Flattened surface at summit of egg about one-third the diameter of the base, with a distinct limitation	sassacus.
Flattened surface at summit of egg almost one-half the diameter of the base, with indistinct limitation.....	metes.
Other species unknown.	

Table of species, based on the caterpillar at birth.

Ranged bristles very much longer than any one of the shorter sections of the abdominal segments.....	sassacus.
Ranged bristles shorter than one of the shorter sections of the abdominal segments.....	metes.
Other species unknown.	

No material exists for any table based on the mature caterpillar or the chrysalis.

Table of species, based on the imago.

Upper half of fore wings above, except the outer margin, almost wholly tawny; in the female the whole upper surface of all the wings with tawny and dark colors in about equal measure; upper organ of male abdominal appendages very strongly arched and bent, so that the proximal and distal portions are nearly at right angles.

Under surface of hind wings with a scarcely perceptible, irregular, mesial band of nearly uniform spots; hook and lateral arms of upper organ of male abdominal appendages separated by a deep cleft, about half the length of the horizontal portion of the organ; hook slender, as viewed from above; two principal teeth at apex of clasp widely separate.....**sassacus**.

Under surface of hind wings with an irregular mesial band, composed of conspicuous spots, seldom uniform; hook and lateral arms of upper organ of male abdominal appendages separated by a slight cleft, not one-quarter the length of the horizontal portion of the organ; hook very stout as viewed from above; the principal teeth at apex of clasp approximate.....**manitoba**.

Upper half of fore wings above almost wholly dark brown; in the female the whole upper surface of all the wings almost entirely dark brown, any tawny tints that may be present being altogether inconspicuous, and mostly confined to reflections; upper organ of male abdominal appendages well arched, but not bent.

Extra-mesial band of under surface of hind wings composed of large, angular, confluent spots, forming a bent series whose outer limits are very irregular from the tongues of white which follow down the nervures.....**metea**.

Extra-mesial band of under surface of hind wings composed of very small, roundish, wholly independent spots, arranged in a bent or curved series.....**attalus**.

GROUP I (comma).

Tawny butterflies; the hook of the antennae is long drawn out and slender, tapering very gently, but originating abruptly from the club; median nervure first forking almost as near the base of the wing as the subcostal fork; upper organ of male abdominal appendages very strongly arched and bent, so that the basal and apical parts lie at right angles.

SPECIES: **sassacus**, **manitoba**.

ERYNNIS SASSACUS.—The Indian Hesperid.

[Orange brown skipper butterfly (Abbot); pale spotted skipper (Maynard).]

Hesperia sassacus Harr., Ins. inj. Veg., 3d ed., 815 (1862);—Morr., Syn. Lep. N. Amer., 110-111 (1862). 98-99 (1884);—Mayn., Butt. N. Engl., 60, pl. 6, figs. 93, 93 ab (1886).

Pamphila sassacus Krb., Syn. catal. Lep., 599 (1871);—Scudd., Syst. rev. Am. butt., 56 (1872); Mem. Bost. soc. nat. hist., ii:346-347, pl. 10, figs. 5, 6; pl. 11, figs. 9, 12, 14 (1874);—

French, Rep. ins. Ill., vii: 150 (1878); Butt. east. U. S., 395-396 (1886);—Fern., Butt. Me., 23, fig. 3, ined.

Figured also by Glover, Ill. N. A. Lep., pl. 23, fig. 3, ined.

The plumed insects swift and free,
Like golden bouts on a sunny sea,
Laden with light and colour, which pass
Over the gleam of the living grass.

SHELLEY.—*The Sensitive Plant*.

And the mad world still dances heedless on
After its butterflies.

LOWELL.

Imago (10: 13, 16). Head covered with mingled deep greenish yellow and blackish hairs, the former much in excess, the tufts at the outer and inner base of the antennae mingled tawny and black; scales beneath and encircling the head pale greenish yellow; palpi rather deep greenish yellow, deepening in tint toward the tip and assuming more

of an orange hue; the outer lateral angle of middle joint with a row of blackish hairs; the upper surface of the same joint where appressed against the head, but not beyond, blackish; apical joint blackish. Antennae above with a narrow band of purplish black much infringed upon by orange tawny, with which the rest of the antenna is covered but which pales beneath almost to whitish, especially toward the outside; apical half of club beneath and the crook naked and dark orange, the apical joint dusky. Tongue black, the tip dark castaneous.

Thorax covered above with deep greenish yellow hairs inclining to brown especially behind; below with greenish buff hairs. Legs rather deep buff becoming dusky toward the extremities above, the femora yellowish beneath. Leaf-like appendage buff, the spurs buff, red-tipped, spines reddish luteous, claws reddish fuscous, pad dusky.

Wings above tawny, paling slightly toward the outer border, especially in the fore wings. *Fore wings* with the outer margin broadly bordered with blackish brown, the interior border usually pretty strongly crenulate and in general forming a pretty regular curve from about the middle of the outer two-fifths of the costal border to the middle of the outer two-thirds of the inner border; but in the interspaces beyond the cell it is suddenly removed outward half the distance to the outer border; in the ♀ it is usually a little broader than in the ♂; following it inwardly in the interspaces beyond the cell is a large, oblong, dusky patch deepening to blackish brown outwardly, occasionally, in the ♂, partially obsolete inwardly; it reaches from the extremity of the cell to the outer bordering, its exterior angles just failing to touch it; in the ♀ almost always, in the ♂ often, it is followed above its basal half by a dusky patch which extends to the costal margin, has a well-defined exterior margin parallel to the outer bordering but interiorly blends into the tawny or, in the ♀, extends along the costal margin broadening the blackish edge always found there; the inner border as far as the submedian nervure is generally slightly dusky in the ♂, almost as dark as the outer border in the ♀; besides, in the ♀, there is a slender dark streak in the cell, and below it, nearly or quite to the last divarication of the median, a broad, dusky or blackish brown, longitudinal patch, replacing the ♂ dash; the latter (43:15; 45:1) is velvety black with a median slit, giving the appearance of a hoary line; it extends from the last divarication of the median to a point scarcely outside of the middle of the basal half of the submedian, is slightly fusiform, tapering more outwardly than inwardly, very slightly arcuate, its convexity above and nearly eight times as long as broad. The edge of the outer border is marked in blackish, the upper two median nervules and occasionally some of the others, especially toward the apex of the wing, are delicately and indistinctly traced in brownish; fringe dirty pale brown, palest outwardly and especially on the lower half of the wing. *Hind wings* completely bordered throughout with blackish brown so as to leave only a central disc of tawny, in which the nervures are usually traced in brownish; this central area is usually larger and more unsullied in the ♂ than in the ♀; the bordering of the costal area is limited by the subcostal nervure excepting that it ordinarily occupies also the basal third of the subcostal interspace; the interior margin of the outer bordering is usually crenulate and not so broad, approaching beyond the cell to within the width of an interspace and sometimes only half an interspace from the outer border; the inner border is very broadly margined, even to the median nervure, although the medio-submedian interspace is often less deeply infuscated and is largely concealed by greenish tawny hairs. Fringe as in fore wings.

Beneath pale, dull, greenish buff, the central portions, and on the fore wings the costal area, tinged with tawny. *Fore wings*; above the lower median nervule and occasionally also below it the outer bordering of the upper surface is indistinctly repeated in a dusky, pale green tint; the median patches of the wing are also repeated indistinctly in dusky shades, and between these and the outer bordering the wing is rather pale, often, and especially in the ♀, developing into an extra-mesial, irregular, pale band, broadening and fading below; the median nervules are usually faintly traced in brownish, the inner margin as far as the submedian nervure is griseous, while the central portion of the base within the median patches is blackish fuscous; the outer border of

the wing is delicately edged with blackish and the fringe is much as above. *Inner wings* with an extra-mesial, bent band, composed of five nearly equal, squarish, usually obscure, pale straw-colored spots, extending from the middle of the outer half of the costal nervure to the middle of the lower median nervure, bent in the interspace beyond the cell at rather less than at right angle; on the lower half of the tip of the cell and at the extreme base of the costo-subcostal interspace are other similar pale spots, still more obscure than they, and often obsolete; occasionally the former and the extra-mesial spots commingle into a common central area, giving the whole wing quite a different appearance; occasionally, too, a few scattered griseous scales collect along the outer limit of the extra-mesial series of spots; the wing is usually duskier in a longitudinal streak, the upper limit of which follows the median nervure and the middle median nervure, but which does not affect the spots; the outer border is delicately edged with blackish and dotted with black at the nervule tips. Fringe pale buff, palest below, more or less infuscated slightly in the ♀.

Abdomen blackish above, the base covered with long, greenish tawny hairs, the sides with scattered but abundant tawny scales, below pale yellowish. Upper organ of male appendages (37:14, 20) strongly arched, very deeply sulcate above posteriorly; hook two-thirds the length of the centrum, nearly straight, equal and very slender as viewed above, tapering delicately as seen from the side, the apical half compressed, laminate; lateral arms similarly compressed, but tapering only at the tip, longer than the hook, widely separated from it at their base, curving upward. Clasps nearly twice as long as broad, not extending nearly so far backward as the upper organ, the upper edge broadly angled near the base, its apical half a little incurved, the sharply pointed apical denticle a little incurved, and separated widely by a deep rounded excision from a much larger, but equally pointed, upturned and slightly recurved tooth at the extremity of the upper margin of the clasp; the recurved edge of the lower margin forms a uniformly serrated lamina supporting the inner anterior edge of the apical tooth, and terminates anteriorly in a pointed upturned tooth opposite, and similar to, the preapical tooth of the upper edge of the clasp.

Measurements in millimetres. Length of tongue, 14.75 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	13.5	14.4	15.	13.75	15.5	16.75
antennae.....	6.4	6.75	7.15	6.6	7.	7.15
hind tibiae and tarsi....	7.75	7.9	8.4	7.75	8.15	9.15
fore tibiae and tarsi....	5.	5.5	5.75	5.	5.6	5.8

Described from 32♂, 17♀.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wings; the scales contained in it consist of jointed threads, the joints distinctly fusiform (46:1a), accompanied by large, quadrangular, equal scales, two or three times longer than broad (1c); the stigma is guarded at the edges by long and slender scales, gradually enlarging from base to apex, the latter truncate with undulate margin (1b, d); the cover scales (1e) large, triangular, well-rounded and elongated.

This familiar species is readily distinguished from the others; the wings are broadly and distinctly bordered above with dark brown, which does not gradually merge into the orange-tawny base; and both sexes have a distinct longitudinal dash of dark brown in the basal half of the interspaces beyond the cell, much more distinct than in the other species; the under surface of the hind wing differs from most of the other species in the faintness of the mesial band.

Egg (66:19, 23). Surface of cells profusely sprinkled with white circular dots, apparently punctuations, averaging forty to fifty to a cell; they are present, also, in the cells of the micropyle, but toward the very summit become elongated; average cells, .04 mm. in width. Micropyle (69:12), .38 mm. in diameter; central cells, .01 by .025 mm. in size; those neighboring, .019 by .042 mm. in size; the outer ones, .038 by .05 mm. Color very pale greenish, almost chalk white at first, a little glistening, but afterwards becoming slightly discolored with dirty yellow. Height, .76 mm.; width,

1.10 mm. The flattened space on summit is narrower than in *E. metea*, being only about one-third the diameter of the base of the egg.

Caterpillar. *First stage* (73:7). Head dark, blackish brown, shining, with numerous shallow punctures, from apparently only a few of which rise hairs about .06 mm. long; ocelli black; mouth parts blackish; first joint of antennae pale, second fuscous, third black. Body white; the first thoracic segment with a brownish fuscous, dorsal shield, black at the posterior border and narrowly margined with black in front; ranged bristles wineglass-shaped, pale fuscous, pellucid at tip, the subdorsal series inclined inward, all .045 mm. long; legs and prolegs concolorous with the body; claws fuscous; the last segment with two pairs of subdorsal bristles, long, recurved, reaching as far back as the anterior margin of the seventh abdominal segment, and closely depressed on the back. Length, 3 mm.; breadth of head, .65 mm.; of body, .5 mm.

Distribution (30:5). This butterfly is a member of the Alleghanian fauna where it reaches from the Atlantic to Colorado, and in addition follows the Appalachians to their southern extremity. It has been found in a comparatively narrow belt of country stretching westward; in New York it has been taken in scanty numbers at Albany, Bethlehem, and Schoharie (Lintner), and on Staten Island (Davis); it has also been found in northern Illinois (Worthington), Wisconsin, not rare (Hoy), Iowa (Allen), Nebraska (Dodge) and in Colorado at Clear Creek Cañon (Uhler); south of this belt it has been reported but from a single locality, Georgia, where Abbot says it is common and from which state I have seen specimens; in all probability it will be found along the whole extent of the Appalachians.

It has been rarely found in the northern half of New England; the only localities known being Norway (Smith), Hallowell (Miss ...worth) and Brunswick, Me. (Packard), and in New Hampshire at Milford where Whitney says it is common, and on the southern side of the White Mountains at Bartlett (Seudder); the other known localities are in Massachusetts,—Williamstown (Seudder), Andover (Sanborn), the vicinity of Boston, very common in such localities as Malden, Winchester, Prospect Hill and Turkey Hill, Milton (Sanborn, Faxon, Thaxter, Minot, Harris, Seudder), Walpole (Miss Guild) and Springfield (Emery); farther south it has been found in Massachusetts on Cape Cod (Sanborn), in Rhode Island at Providence (Sanborn), and in Connecticut about New Haven (Verrill, Smith).

Food and habits of caterpillar. The caterpillar is easily bred on common grasses. Mr. Abbot specifies the crab grass—*Panicum sanguinale* Linn. as its food plant in Georgia. The larva is more plump than many other grass feeding Hesperidae.

The caterpillar is sluggish at the beginning of its life as afterward. It takes it from twelve to eighteen hours to effect its escape from the egg, and it remains nearly a fortnight in its very first stage. In this stage it gets between the leaves of grass close down to their union with the stem and uses the mere crevice for a nest, apparently without any silken fastenings.

Its habits are not specially cleanly as in most other skippers, for it soils its own nest considerably.

Life history. The insect in single brooded in the north, double brooded in the south, probably passing the winter as a chrysalis. In the south, the butterfly appears by the middle of April and again at the end of August, after ten days passed in the pupa (Abbot).

In New England it is one of the earliest of the Pamphilidi, the earliest butterflies being seen during the last week in May, the female scarcely later than the male; sometimes they are not seen before the middle or latter part of the first week of June, but they are generally out by this time in the northernmost limit of their range and they evidently continue to emerge from the chrysalis until the middle of the month and remain on the wing through this month; sometimes battered individuals may be found until the middle of July. The female begins to lay eggs by about the 10th of June; these hatch in from twelve to fifteen days, but the further history of the caterpillar has not been traced, excepting that some I had remained in this stage until past the middle of July.

The butterfly frequents fields and meadows.

Desiderata. The exact distribution of this butterfly outside of New England and the completion of its history after it has left the egg are the principal desiderata in our knowledge; the parasites of the insect and the flight and postures of the butterfly are yet undescribed, and we do not know how the winter is passed.

LIST OF ILLUSTRATIONS.—ERYNNIS SASSACUS.

- | | | |
|---|--|--|
| <i>Egg.</i> | | Pl. 37, figs. 14, 20. Male abdominal appendages. |
| Pl. 66, fig. 10. Plain. | | 42: 10. Neurulation. |
| 23. Outline. | | 43: 15. Discal stigma of fore wing of male. |
| 69: 12. Micropyle. | | 45: 1. The same, greatly enlarged. |
| <i>Caterpillar.</i> | | 49: 1. Scales of the discal stigma. |
| Pl. 73, fig. 7. Caterpillar at birth. | | 59: 8. Side view of head and appendages enlarged, with details of leg structure. |
| <i>Imago.</i> | | <i>General.</i> |
| Pl. 10, fig. 13. Female, upper surface. | | Pl. 30, fig. 5. Distribution in North America. |
| 16. Male, both surfaces. | | |

ERYNNIS MANITOBA.—The Canadian skipper.

Pamphila manitoba Scudd., Mem. Bost. soc. nat. hist., II: 351, pl. 10, figs. 8-11; pl. 11, figs. 7-8 (1874);—Speyer, Can. ent., xv: 143-145 (1885);—Edw., ibid., 147-148 (1883).

Pamphila comma (pars) Streck., Cat. Amer. Macrolep., 167-168 (1878).
[Not *Papilio comma* Linn.]

How sweet to listen to the dove
When all the rest forget to sing,
And watch the swallows wantoning,
And butterflies, the gold whereof
Comes sinking through the skies above
Like feathers from an angel's wing.

LOUIS BELROSE.—*Midsummer*.

Up and down, up and down,
I will lead them up and down.

SHAKESPEARE.—*Midsummer-Night's Dream*.

Imago (17:1, 4). Head covered above with mingled pale yellow, greenish yellow and black hairs with many fulvous ones at the sides, next the base of the overarching pencil of fulvous and black hairs which extends above the eye; behind the eye packed with many pallid scales. Eyes black. Antennae pale tawny beneath, blackish brown above, flecked with black scales; the club blackish above with purplish and greenish reflections, orange beneath and at the sides, pearly white on the outer side, the naked portion including the hook black with ferruginous tinge. Palpi covered almost wholly with greenish yellow scales and hairs with many intermingled white hairs on the sides and beneath and a lateral fringe of forward projecting black hairs; apical joint with many intermingled black hairs above and a greater or smaller number of brownish hairs below.

Thorax covered above abundantly with dark greenish yellow scales, having a decided ferruginous tinge, becoming paler posteriorly and all concealing the minute black scales which cover the immediate surface; beneath covered with pale greenish yellow scales paler beneath than at the sides. Femora covered profusely with whitish scales, but above and especially apically fulvous, and fringed with long, pale yellowish green or whitish hairs; all the tibiae and tarsi thickly clothed with fulvous scales above, with pallid scales beneath; the spines dark castaneous; the spurs the same, tipped with blackish and heavily scaled beneath with white; claws blackish castaneous; pulvilli black.

Wings above tawny, more or less impure, and marked with brown of a lighter or deeper tint, generally darker in the female than in the male. *Fore wings* with the costal edge blackish brown, the outer margin broadly bordered with dark brown, having an ill-defined interior border, but usually set off to a greater or less extent by the extra-marginal row of spots, more distinct in the female than in the male, following the usual course of these spots in this genus; in the female, the basal half of the wing is much obscured below the cell with blackish brown, sometimes rendered somewhat obscure by a flecking of fulvous hairs; especially are to be noted two large spots at the base of the lower median interspace and in the medio-submedian directly beneath it, spots which in the male are always fulvous. The discal stigma of the male (43:8) consists of a slightly arcuate streak, broad at base and tapering at tip, which extends from the submedian nervure to the base of the second median nervure, composed of a basal, velvety, black, roundish patch, a narrow streak of erect velvety rods, following the lower margin of the cell, and beneath the latter and bounded basally by the former a brown line almost entirely concealed by the roof-like arrangement of large, steel-gray, overarching scales. *Hind wings* narrowly (♂) or broadly (♀) bordered with blackish brown on all the margins, the nervures often rendered distinct by the same and a vague pale fulvous repetition, more distinct in the female than in the male,

of the markings of the under surface; the outer edge of all the wings marked with a black thread, the fringe dark brown at base, on the lower half of the fore wing, and on the upper two-thirds of the hind wing, especially the latter, followed more or less distinctly by white.

Beneath: *Fore wings* fulvous, the apical third much flecked with greenish yellow scales, crossed in the middle of the outer half of the wings by an exceedingly irregular transverse series of spots, far more conspicuous in the female than in the male; in the latter they are confined almost altogether to two or three often obsolescent subcostal spots midway between the apex of the cell and of the wing, and to two invariably present, subconfluent, subquadrate spots in the interspace beyond the cell, distant from the outer margin by from one-half to the whole of an interspace; in the female these markings are always conspicuous in all their parts and hold a similar position and rarely are connected at the lower outer corner of the upper and the upper inner corner of the lower, but usually are separated from each other by their own width; beneath this, in the female, rarely in direct connection with the preceding, is a series of three large subquadrate lunules in the median and medio-submedian interspaces, increasing in size from above downward, the lowest generally very vague, fading out on either side, the others rendered much more conspicuous by the suffusion of the whole part of this wing on either side of these spots by blackish brown, which is almost totally wanting in the male, where these spots are indicated by a pallid wash rarely with any distinct margins. *Hind wings*: excepting for the markings, the wing is almost uniformly greenish yellow, varying, however, from a bright olivaceous to a dark greenish gray; the markings consist of a white spot, round or angulate at the apex of the cell, very variable in form, not infrequently extending over the median nervule into the interspace below and running along this nervule toward the base; in such case it is always accompanied by a similar, triangular, elongate spot at the extreme base of the costo-subcostal interspace, more commonly present in the female than in the male; further, of the extra-mesial series of spots common to this genus, which here consist of white spots usually quadrate, those in the median area generally confluent or subconfluent, especially in the female, occasionally intensified by a black edging and altogether at their fullest forming a belt bent at right angles or a little less, across the wing; very rarely all the spots are connected and in such case tongues of white scales are thrown out from the band along the nervules on either side, especially on the outer; the upper portion of this bent band consists of two spots in the costo-subcostal and subcostal interspaces, the upper sometimes absent, often reduced to a mere dot, the lower generally quadrate or at least quadrangular, not infrequently rhomboidal, and situated in the middle of its interspace; the spots in the interspace beyond the cell are almost always confluent and form a transverse subquadrate spot generally excised on the inner margin, usually distant from the outer margin by the width of an interspace; the remaining spots forming the lower arm of the bent band are sub-parallel to the outer border and their outer margin is as far from the same as the inner margin of the spots in the interspace beyond the cell; they are subequal, generally quadrate. Fringe much as above.

Abdomen blackish brown, much flecked with pale fulvous scales on the sides and with whitish scales beneath and at tip. Upper organ of male appendages (37:5,9) roundly and strongly bent at base, beyond straight; hook scarcely a fourth the length of the centrum, being exceptionally brief, curved, gently tapering to a blunt point as seen from the side, semi-ovate, not much longer than broad as seen from above, with a slight median sulcus; lateral arms slender, gently tapering, pointed, curved slightly upward. Clasps nearly twice as long as their basal breadth, reaching backward nearly as far as the upper organ, tapering regularly, the upper edge sharply though only slightly excised next the inner base of the inner spine, the upper apex, including the apical spines, incurved, the spines of about equal size and separated by a narrow space, perhaps equal to the middle width of one of the spines; the recurved edge of the lower margin has a single denticle next the apical spines.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	13.25	14.75	15.25	13.8	16.	16.75
antennae.....	7.	7.75	7.6	6.	7.5	7.5
hind tibiae and tarsi..	7.	8.5	8.2	6.75	8.	8.5
fore tibiae and tarsi..	4.5	5.6	5.5	4.6	5.5	6.

Described from 13♂, 10♀.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wings; the scales contained in it consist of slender jointed threads, the joints gently fusiform (49:2 g), accompanied by very slender and very slight spatulate rods (2 d); the stigma is guarded at the edges, especially the upper edges, by two-pronged rods or rod-like scales in different parts of the stigma (2 a, b, c); the cover scales above are large, quadrangular, well rounded, a little larger apically than at the base (2 f); the field below the stigma is composed very largely of triangular scales of varying sizes, finely striate (2 e, i, l), while others are more quadrangular in form and vary similarly in size (2 h, k).

Comparisons. This species is the most nearly allied to the European *P. comma* of all American species; the size of the two is the same, and the upper surface of the females vary in each species to the same extent; there are no constant features of distinction in the upper surface of the male, although in the present species the hind wings are usually devoid of the appearance of the spots on the under surface, which generally are faintly but exactly marked upon the upper surface in the European species. The under surfaces of the two species also resemble each other closely, and it is a little difficult to define in words the distinctions which are apparent; the ground color inclines more to deep green in *P. comma*, and the mesial bent band of the hind wings is rather more uniform; in the male it seldom departs from a certain regularity of disposition, the spots being nearly equal, arranged in a line bent at a little less than a right angle, occasionally broken into spots, and sometimes with a narrow black bordering to the spots upon the inner and outer side. In the male of *P. manitoba*, the spots generally diminish in size toward the middle of the wing, and from the greater approximation to the outer border (shown by the spot in the interspace beyond the cell), the band is bent at considerably less than a right angle; the spots are never bordered with black, at least in specimens I have seen. The female of *P. comma* agrees very well with the male of the same in its characteristics, only the band is somewhat broader, and perhaps more frequently made up of detached spots, while the female of *P. manitoba* differs to a greater degree from its male, the spots showing greater tendency to become equal in size, to separate from each other, and even to become margined slightly with black; it is therefore less readily distinguished from the same sex of *P. comma* than the males are; there is also great variation in the breadth of the band or the size of the spots, for while usually larger than in the male (as in most species) they are sometimes many times larger, and occasionally almost as small as in the most delicately marked males.

Distribution (30:6). This butterfly belongs to the Canadian fauna where it reaches across the country, following the southern border of the Dominion of Canada from Quebec to Vancouver. That it is more particularly a western species is shown by its great latitudinal distribution in the west, as it appears to follow down the coast ranges to central California and the Rocky Mountains as far as Colorado. It has not been discovered in the intervening elevated plateau or on the mountain ranges, but is not likely to be altogether absent. Thus, along the Pacific coast it has been

found in Calaveras County, Cal. (Brehens), near Truckee, Nev. (Mac Glashan), Fort Klamath, Or. (Merrill), Washington Territory (Edwards), and Vancouver Island (Fletcher); it has also been found at Lake La Hache (Crotch), Pike's Peak and Manitou, Col., Regina (Fletcher), and the east coast of Lake Winnipeg, which is also the northernmost locality (Scudder); coming further eastward, Nepigon and Sudbury (Fletcher), and finally at Rivière du Loup, nearly opposite the mouth of the Saguenay River on the Lower St. Lawrence (Couper).

This last locality is our warrant for including it in this portion of the present work.

Life history. The data for the seasons of this butterfly are extremely few and somewhat discordant. That it appears about the first week in August or perhaps the last of July and flies until toward the middle of September is tolerably clear from the uniformity of dates of capture of different specimens. Whether, however, this is the only brood is uncertain, for specimens apparently to be referred to this species have been taken in Colorado early in June and in California even at the last of April. If these are correctly given, it would seem probable that the second brood had been more frequently observed and is, therefore, the more abundant. This is the meagre sum total of our knowledge of this species, the full history of which will probably have to be worked out in the west.

LIST OF ILLUSTRATIONS.—ERYNNIS MANITOBA.

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| <i>General.</i> | | Pl. 17, fig. 4. Male, both surfaces. |
| Pl. 30, fig. 6. Distribution in North America. | | 37: 5, 9. Male abdominal appendages. |
| <i>Imago.</i> | | 43: 8. Discal stigma of fore wing of male. |
| Pl. 17, fig. 1. Female, both surfaces. | | 49: 2. Scales of discal stigma. |

GROUP II (*metea*).

Dark brown butterflies; the hook of the antennae is short and stout, rapidly tapering and not originating very abruptly at base; median nervure first forking very much further from the base of the wing than the first subcostal fork; upper organ of male abdominal appendages well arched, but to no such extent as in the other section.

SPECIES: *metea*, *attalus*.

ERYNNIS METEA.—Cobweb skipper.

[Cobweb skipper (Scudder); White banded skipper (Maynard).]

- Hesperia metea* Scudd., Proc. Ess. Inst., figs. 88, 88a (1886).
 ill: 177-178 (1863);—Min., Proc. Bost. soc. nat. hist., xii: 319-320 (1869).
Ocytes metea Scudd., Syst. rev. Am. butt., 55 (1872); Butt., fig. 45 (1881).
Pamphila metea Kirt., Syn. catal. Lep., 607 (1871);—French., Butt. east. U. S., 306-307 (1886);—Mayn., Butt. N. Engl., 58, pl. 7.
Isoteinon metea Hew., Cat. coll. diurn. Lep., 228 (1879).

Happy creature! what below
 Can more happy live than thou?

Sipping o'er the pearly lawn
 The fragrant nectar of the dawn.

ANACREON.

Imago (10: 5, 11). Head and collar with transverse ridges of long, blackish scales, edged and tipped very frequently with fulvous and paler ones. Palpi plump, with long white scales, with a few intermingled pale fulvous and black scales, covered with black scales above, where concealed by their position next the head; apical joint inconspicuous, naked, dark reddish brown; in front of the antennae a tuft of rather short, fulvous hairs; behind the antennae a slender tuft of longer fulvous hairs, and behind these a tuft of shorter whitish hairs; stalk of antennae blackish brown, the inclosures black, beneath hoary, with whitish hairs; club blackish, above with a broad stripe of fulvous scales growing tawny toward tip, which the band does not reach; beneath and at sides with the whole basal half covered with hoary scales; all of the bent portion black. Tongue black, excepting at extreme tip, where it is deep mahogany brown.

Thorax purplish black, obscured by long, dark greenish and greenish yellow hairs, beneath whitish; femora and coxae densely clothed with very long, dull fulvous and whitish hairs, directed backward; femora covered with blackish brown and with mixed hoary and fulvous scales, the latter more conspicuous above and sometimes on the outer side; tibiae and tarsi reddish brown, the whole more or less obscured and made gray by mingled brownish, whitish, and fulvous scales; the last joint of tarsi and claw blackish; spines reddish; spurs reddish, black tipped, clothed with hoary scales.

Wings above; *fore wings*, basal portion in the male above and within the stigma, and also the inner border below the submedian nervure, brownish fuscous, sprinkled heavily with fulvous scales, except along the subcostal nervure, where they are much less frequent; outer half of costal border and outer border broadly obscured with brownish fuscous, flecked inconspicuously and very sparsely with fulvous scales, and tinged in certain lights with purplish; within this region are five whitish or dull yellowish white spots, three elongated, broken, wedge-shaped ones, one above and a very little outside of another, halfway between the tip of the cell and the apex of the wing, included between the subcostal veinlets; two subquadrate, submarginal ones, one on either side of the upper median nervule, and one large, very strongly elongated lunule at the base of the middle median interspace; the male stigma (43: 1) consists of a narrow band of slaty scales, bordered above with black and tinged with purplish in certain lights, starting from the submedian nervure at two-fifths the distance from the base, and extending in nearly a straight line toward the last divarication of the median; it has a very gentle curve, whose open side is outward, and just before reaching its termination curves a little more outward and terminates close beside the divarication of the median; the velvety black scales are much more prominent in a spot at the submedian nervure, and a broad, straight streak at the other termination, which borders the median nervure, and impinges on the last divarication of the same.

Between the sexual band and the marginal obfuscation the wing is fulvous. *Hind wings* blackish fuscous obscured, except broadly along the costal border and very narrowly along the median nervure, by long, greenish fulvous hairs and fulvous scales, and brightened near the outer margin by an abruptly bent, rather conspicuous band, corresponding to the one on the under surface, of yellowish and fulvous scales, obliterated below the first median nervule; both wings edged narrowly with black along the outer border; the fringe ashy at base, dirty white at tip.

Beneath, *fore wings* with the general position of the markings as upon the upper surface; the basal part of the wing is blackish brown, obscured by slender, longitudinal streaks of fulvous scales and hairs along the costal border; apical portion of wing, exclusive of the whitish spots, which replace, but more largely, the whitish fulvous spots of the upper surface, pale brown, with pale fulvous scales interspersed; the large spot in the median field is whitish, tinged faintly with fulvous, and reaches the border near the inner angle. *Hind wings* dark brown, with paler brown and fulvous scales sparsely interspersed; faint spots of pearly white scales are found on the costal border near the base, and just below the apical half of the cell, extending also into the cell; a few white scales follow the internal vein, but the most conspicuous of all is a broad, transverse band of pearly white scales, somewhat obscured in the costal region by very pale pearly brown scales; the inner edge of this band arises near the middle of the costal border and passes in a series of gentle waves, the general direction of which is a nearly straight line, subparallel to the submedian nervure, to the middle of the interspace between the last branches of the subcostal, at about two-thirds the distance from the divarication to the outer edge; here it is abruptly bent at much less than a right angle, and passes in a series of very gentle curves in a general slightly bowed direction, scarcely subparallel to the outer border, and terminates at the submedian nervure; the outer edge of the band is subparallel to the inner, but more irregular in outline, and is bent at about a right angle; the band is broadest in the costal field and reaches the border in the last interspace internally; near the middle of the costal border an ovate brownish spot is included between the transverse band and the costal spot of white scales; the anal border and the anal angle are largely sprinkled with fulvous scales.

Abdomen purplish black, obscured by long, dark greenish and greenish yellow hairs, beneath whitish, the apices of the segments above and at sides frequently marked by fulvous and paler scales. Last segment of male cylindrical, densely covered with long, fulvous and black scales, which extend beyond the edge of the segment by nearly the length of the latter and leave an obscure terminal opening; when denuded, the segment is seen to be obliquely docked, and the appendages (37:6) protrude slightly beyond the terminal orifice. The upper organ is nearly twice as long as broad, tapering from a little before the middle, the sides of the centrum expanding, just before its extremity, into a rounded lobe, abrupt anteriorly, the hook preserving the curve of the centrum and tapering, at first rapidly, afterwards more gently; lateral arms not nearly so broad at the base as the hook, tapering regularly to a point. Clasps fully half as long again as the basal breadth, the inner spine the longer, both a little incurved and finely pointed, separated from each other by more than the width of their base.

Measurements in millimetres. Length of tongue, 13-13.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	13.25	13.5	14.		15.	15.25
antennae.....	6.5	7.	7.			
hind tibiae and tarsi..	7.1	7.5	7.3			8.2
fore tibiae and tarsi..	4.2	5.	5.5			5.25

Accessory sexual peculiarities. The discal stigma of the male has been described under the wings; the scales contained in it consist of jointed threads with uniform slender joints (48:7 c), accompanied by a very varied assortment of subspatulate or spatulate rods and elongated scales; sometimes also trilobed, those in the inner stigma being figured at 71, k, l, those in the outer stigma at 7 e, h; the upper base of

the outer stigma is edged by two-pronged or three-pronged slender, equal scales (7 d, f) and accompanied by some quadrangular scales with truncate and slightly toothed apical margins (7 g); in the field below the stigma are found triangular striate scales with strongly convex apical margins (7 b), or more elongated forms with less convex margin, slightly enlarged at the outer edges (7 a).

Egg (66: 30). Surface covered with very inconspicuous punctations, very numerous, being 40 or 50 to a cell, almost circular but slightly ovate, not more than .002 mm. in diameter; cells averaging from .025 mm. to .042 mm. in width; color dead parchment white; height, .68 mm.; breadth, 1.04 mm.

The egg is fuller in the upper half than that of *E. sassacus*.

Caterpillar. *First stage.* Head (80: 52) very dark castaneous, almost black, shining; the surface with distant, irregular, impressed lines and furnished with rather distant, short, delicate, whitish hairs, each inserted in a slight and shallow punctation; ocellar field black; first joint of the antennae pale, second fuscous, third and fourth black, the bristle black; palpi castaneous, the second and third joints paler at tip; mandibles dark castaneous. Body white with a very faint greenish tinge; dorsal thoracic shield castaneous, its anterior edge and a line nearest the posterior edge black; dermal appendages pale or slightly dusky, those of the upper row directed inward a little, those of the next row slightly forwards; the last segment has very long pale hairs directed at first upward and then backward; first thoracic legs dusky, the terminal joint black; other thoracic legs white, the two apical joints slightly dusky; prolegs pale; spiracles pallid with a dusky annulus. Length of body, 2.4 mm.; breadth of head, .5 mm.; of body, .65 mm.

Distribution (30: 7). This member of the Alleghanian fauna is hardly known outside of New England or its immediate border, the only extra limital localities from which it has been reported being Albany, N. Y., where Mr. Lintner finds it "plentiful" and where I have taken it with him, and Wisconsin where Hoy says it is common. Edwards also reports it from Texas, but this would seem to need special verification.

In New England it is confined to the southern half, the northernmost known station being Milford, N. H., plenty (Whitney). In Massachusetts it has been found several times, but never abundantly, in the immediate vicinity of Boston (Faxon, Minot), in Springfield, a single specimen (Emery) and Middleboro common (Hambly). The only other localities from which I know it are in Connecticut, Farmington (Norton) and New Britain (Hulbert, Scudder).

Oviposition. The only eggs I have obtained were sent me by Mr. Hambly, laid in the box in which the female was imprisoned, mostly on the sides, a few on the bottom; they hatched in two weeks.

Food and habits of caterpillar. The caterpillar feeds upon grasses although never yet raised to maturity upon them. It is very sluggish at birth, for in eating its way out of the egg it takes four or five nibbles to cut off a single roundish slice of about the size of one of its own mandibles, after which it waits a great while before resuming its labors, so that the completion of its task requires a long time; the mere act of crawling from the egg occupies half a minute; it weaves a web with every step down the side of the egg and when its hinder extremity is about half way down the declivity, it turns upon its track to devour the remainder of the shell; one caterpillar which ate less than three-fourths of its former abode was seven-

teen minutes in accomplishing this task. Another was five or six hours in gnawing the opening and devouring the shell.

Life history. Although this Pamphilid is the earliest of its tribe, it is nevertheless single brooded; unquestionably it passes the winter as a chrysalis, as it appears on the wing in May, usually during the early part of the last week but occasionally even by the middle of the month; the female usually appears about four days after the male and begins to deposit her eggs but a few days thereafter, that is, during the first week in June; the insect continues on the wing throughout June; the eggs hatch in a fortnight but the subsequent history of the caterpillar has not been traced; it should be easy to do so. Mr. Hambly found the butterfly in but a single locality in Middleboro in open ground; frequently resting upon violet blossoms, as Mr. Lintner says, it is usually found about shrubbery.

Desiderata. The history and description of the caterpillar and chrysalis of this insect, the habits of the caterpillar and butterfly, the attitudes, peculiarities of flight, stations and geographical distribution of the butterfly, are the principal lacunae in our knowledge. The life history must be perfectly easy to trace, exceptionally so for a single brooded skipper.

LIST OF ILLUSTRATIONS.—ERYNNIS METEA.

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|---|--|
| <i>Eggs.</i> | Pl. 42, fig. 1. Neuration. |
| Pl. 63, fig. 30. Outline. | 43: 1. Discal stigma of fore wing of male. |
| <i>Caterpillar.</i> | 48: 7. Scales of the discal stigma. |
| Pl. 80, fig. 52. Front view of head in stage 1. | 58: 8. Side view of head and appendages enlarged, with details of the structure of the legs. |
| <i>Imago.</i> | <i>General.</i> |
| Pl. 10, fig. 5. Male, both surfaces. | Pl. 30, fig. 7. Distribution in North America. |
| 11. Female, upper surface. | |
| 37: 6. Male abdominal appendages. | |

ERYNNIS ATTALUS.—The dotted skipper.

Pamphila attalus Edw., Trans. Am. ent. soc., iii: 276 (1871).

Ocytes seminole Scudd., Syst. rev. Am. butt., 55 (1872).

Pamphila seminole Edw., Cat. Lep. Amer.,

51 (1877);—French. Butt. east. U. S., 300 (1886).

Pamphila attalus var. *seminole* Streck., Cat. Amer. Macrolep., 169 (1878).

She pluck'd a wildwood Rose and fondly strove,
With pausing step and ever anxious care,
To carry home her dainty treasure-trove.
A butterfly perch'd on those petals fair,
Soon the gay creature flutter'd off again;
And then her girlish fingers dropped the flower.
Ah! little maid, when Love asserts his power,
This lesson duly learnt may save thee pain;
Why from the forest Rose thine hand unclasp,
Because the fickle insect would not stay?
Not all the tendance of thy sweet blue eye,
And tiptoe heed, secured the butterfly;
The dower that needed but thy tender grasp
To hold it, thou hast lightly thrown away!

ELIZA TURNER.

Imago (17: 9, 12). Head covered above with a mass of mingled pale and dark olivaceous, black and fulvous hairs, concealing to a greater or less extent the scales beneath, which vary from pearly gray in the female, sometimes with a greenish tint, to blackish brown in the male; in both a cluster of white scales above the eye directly

behind the over-arching pencil of mingled blackish and dark tawny hairs; behind the eyes a cluster of mingled white and yellowish scales. Antennae blackish brown above, faintly annulate at the tip of the joints with black, clay brown beneath, extending far upon the club, which otherwise is black brown with a purplish reflection, flecked with some steel gray scales; naked apical portion of the club and hook luteo-ferruginous. Palpi dirty white washed with yellow, the white most noticeable along the middle, sparsely flecked throughout with black hairs; the apical joint light brown, above darker, sometimes blackish. Eyes piceous. Tongue blackish castaneous, castaneous at tip.

Thorax covered with long fulvous and olivaceous hairs, when fully clothed almost entirely concealing the purplish black and steel gray scales which cover it profusely; beneath covered with pale yellowish and whitish hairs, and some slate gray scales. Legs completely covered above with pale clay yellow scales, the femora with heavy fringes of very pale yellowish hairs; spines testaceous, on the tarsi slightly darker than on the tibiae; spurs the same but clothed with pale clay scales, castaneous at the tip; claws dark castaneous; pulvilli black.

Wings above very dark purplish brown (δ) or dark brown (φ), with pale tawny (δ) or pallid (φ) markings. *Fore wings* in the male with a discal stigma composed of two slender, scarcely arcuate, black lines in the medio-submedian and lowest median interspaces, roofed in by steel gray arching scales above and below; the upper stigma followed on the outer half of its upper limit by a patch of black rods and the extreme base of the lower stigma with a roundish patch of the same; this stigma divides two tawny areas: the upper one, more or less pallid, is found at the extremity of the cell where outwardly it terminates abruptly; the other forms the lower part of an irregular extra-mesial series of fulvous spots, consisting, first, of three short dashes in the subcostal interspaces, one directly over the other, generally increasing in length from above downward and placed at just less than half way from the tip of the cell to the tip of the wing; these are followed by two dots, one above the other, in the subcosto-median and upper median interspaces, parallel to the outer border, a little outside of the outermost of the subcostal spots; and in the median interspaces below these a fulvous band following the lower margin of the stigma, broken by the interspaces and running in a straight line from the dots previously mentioned to the middle of the inner border, broadening as it passes. All these tawny markings are replaced in the female by pallid and the markings differ further in that the spot at the extremity of the cell is shorter, has a more distinct inner margin, and that in the medio-submedian interspace is very much reduced in size. *Hind wings* with a faint repetition of the markings of the under surface, either tawny (δ) or very pale tawny (φ); in the latter the ground of the entire wing much obscured by tawny hairs. Fringe of all the wings of the color of the upper surface on the basal half, apically much more pallid, excepting on the upper half of the outer border of the fore wings; its extreme base marked by a blackish brown thread.

Beneath: *fore wings* dark brown (δ) or pale brown (φ), in the parts not covered by the hind wings rather heavily dusted with tawny scales; the markings of the upper surface are repeated beneath but more vaguely and in paler colors, especially in the male, the position of the stigma being marked by a blackish brown stripe. *Hind wings* of the same ground color as the fore wings but very heavily dusted with tawny scales, the markings consisting of a small round whitish spot at the extremity of the cell and an extra-mesial series of similar spots, forming a bent band running from the subcostal interspace to the lower median interspace inclusive, bent at a right angle in the subcosto-median interspace, where the spots are two in number, smaller than the rest, side by side, and distant from the outer margin by the width of the interspace; fringe of both wings as above.

Abdomen dark brown, more or less flecked with lighter brown scales, especially at the incisures and beneath. The upper organ of the male appendages (37: 7) is fully twice as long as broad, the centrum strongly arched, the tapering hook nearly straight, slightly downcurved apically; lateral arms slender, equally straight, tapering regularly,

upcurved a little apically to meet the hook of the centrum. Clasps nearly twice as long as the basal breadth, the upper edge excised before the inner spine, both spines similar, slender and finely pointed, separated by the narrowest possible slit, followed at their inner base (invisible externally) by a lesser dentiform spine.

Measurements in millimetres. Length of tongue, 17 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	14.75		15.75	15.	17.	18.
antennae.....	7.5			6.5	6.9	6.9
hind tibiae and tarsi..			8.75	7.9	8.	8.15
fore tibiae and tarsi..	5.4		5.6		5.6	5.7

Described from 2♂, 9♀.

Dimorphic forms. ERYNNIS ATTALUS QUAIAPEN. The above describes what I regard as the normal female of this species, ERYNNIS ATTALUS ATTALUS, the markings resembling more closely those of the male than in a second form of the female which seems to be quite as abundant as the first. This differs from the normal form mainly in the darker ground color of the wings, which is almost precisely that of the male, but further in the lack of fulvous hairs upon the upper surface, which give the warm appearance to the hind wing of the normal type, and in the less conspicuous markings, those of the fore wings being almost white but very much reduced in size, the extramarginal series of spots being subequal throughout, formed almost altogether of minute spots and streaks, excepting that the spot in the lower median interspace is sometimes quadrate and considerably larger than the others; on the under surface these same markings are usually more distinct than in the normal type, being more sharply defined and more uniform.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wings; the scales contained in it consist of jointed threads, the joints slender and equal in the heart of the stigma (48: 5 h), accompanied by some very slender, graceful androconia, the apex convex (5 d) or roundly excised (5 g); at the base are found some feebly two or three-pronged, rod-like scales, sometimes enlarged apically (5 e, f) and above the apex of the stigma large, equal or apically enlarged, round-tipped cover scales (5 a, b); in the field below the stigma large, triangular scales, feebly and slightly undulate at the apical margin (5 c).

This is a Carolinian species (30: 8), which seems to be tolerably abundant in the south and apparently extends some distance into the Alleghanian fauna. It has been found throughout the south from Texas (Boll) to Florida (Morrison) and is credited to North Carolina by Edwards. In the northern states it has been found at Racine, Wis., not rare (Hoy); in Iowa, according to Edwards, and in New Jersey from which place I have seen specimens.

Several individuals were captured on one occasion in Belmont, near Boston, Mass., by Mr. Roland Thaxter. This is its only known occurrence in New England.

We know absolutely nothing concerning the life history or even the seasons of this butterfly, no single date of capture having been recorded. There is, indeed, no other butterfly of our fauna of which so little is known.

LIST OF ILLUSTRATIONS.—ERYNNIS ATTALUS.

General.

Pl. 30, fig. 8. Distribution in North America.

Imago.

Pl. 17, fig. 9. Female, half of upper surface.

12. Male, both surfaces.

37: 7. Male abdominal appendages.

48: 5. Scales of discal stigma of fore wing of the male.

ATALOPEDES SCUDDER.

*Atalopedes** Scudd., Syst. rev. Amer. butt., 57 (1872). *Hesperia* pars Auctorum.
Pamphila pars Auctorum.

Type.—*Hesperia huron* Edw.

The fairest, the freshest of flowers bring hither,
 With the dew on their petals like glistening pearls;
 Blend their hues and arrange them with care ere they wither,
 Spray by spray in the hair of these ravishing girls.

Butterflies of all colours, the gayest—the brightest,
 Rainbow-tinted—bespangled,—likewise hither bring;
 Let the thrall of the captives be one of the lightest;
 Displace not the bloom of one azure-tipped wing.

Now, watch me, and mark, when I hold up my finger,
 Let their gauzy wings once more in freedom rejoice;
 "On whose head the butterflies love most to linger,
 "That girl shall be queen—she's the butterflies' choice."

SENT.—*The Jade Chaplet.* (From the Chinese.)

Imago (59:6). Head very large, heavily clothed with rather short hairs, mostly arranged in transverse masses; outside of the antennae a small, spreading bunch of slightly arcuate bristles, passing less than one-third way around the eye. Front protuberant but not very tumid, lying wholly beyond the front of the eyes, with a broadly rounded, transverse ridge in the middle of the lower two-thirds, which, viewed anteriorly, is pretty regularly and considerably arcuate; a distinct, arcuate, longitudinal sulcation in the middle of each lateral half; the whole piece scarcely three times as broad as long; the front border is marginate in the middle, and curves regularly around to the outer edge of the antennae; it is separated from the vertex by a straight sulcation, distinct only in the middle half, which is scarcely in advance of the middle of the antennae. Vertex slightly arched longitudinally, flat transversely, the anterior half just reaching the level of the eyes, behind sloping off and separated from the occiput, which is pretty deeply sulcate longitudinally in the middle, by a brace-shaped, slightly impressed line. Eyes pretty large, not very full, nearly circular, naked. Antennae inserted with their hinder edges in the middle of the summit; separated from each other by more than three times the diameter of the basal joints, the whole antenna slightly shorter than the abdomen, composed of thirty-seven or thirty-eight joints, of which eighteen to twenty form the club, which is about two-fifths the length of the stalk, the crook consisting of four minute, slenderly tapering joints, together about three times as long as broad, but considerably shorter than the greatest width of the club; the latter, exclusive of the crook, is stout oval, from three to four times as long as broad, tapering gradually at base, broadly rounded at tip, largest at from the sixth to eighth joint from its base; middle joints of the stalk three times as long as broad; the third joint from base of antennae five times as long as broad. Palpi short and very stout, very broad and flat when viewed from the front, fully one and one-half times longer than the diameter of the eye, clothed very compactly with a very heavy mass of not very long scales, which the apical joint, also clothed heavily but with recumbent scales, surpasses but slightly; basal joint bullate, triquetral, subpyriform, with a tumid expansion on the inner border of the extremity, as long as broad; middle joint large, bullate, a little arcuate, obovate, slightly appressed, broadly rounded at either extremity, but squared a little at the upper inner extremity, considerably broader than the basal joint, slightly more than twice as long as broad, scarcely shorter than the vertical diameter of the eye; apical joint originating at the outer border of the extremity of the middle joint, directed at right angles to it, straight, cylindrical, slightly tapering, rounded at either extremity, about three times as long as broad, and half as long as the greatest breadth of the middle joint.

* ἀτάλος, πηδάλω, the lively skipper.

Prothoracic lobes not very large, more than half as long again as high, about three-fourths as long as the shorter diameter of the eye, the inner three-fifths nearly square, the outer a triangle of about half the size, the inner border and inner half of the upper border straight and at right angles to each other. Patagia pretty large, three-fourths as long as the breadth of the head, the posterior lobe about half as broad and nearly twice as long as the base, straight, equal, tapering only near the tip, where it is rounded.

Fore wing (42:11) twice as long as broad; the lower outer angle falling distinctly outside the middle of the costal margin; the form of the wing precisely as in *Erynnis*. The costal nervure terminating a little beyond the middle of the costal margin; the subcostal nervure closely approximate to the costal margin; the second nervure originating just before the middle of the wing; cell two-thirds as long as the wing, very slender, and increasing regularly and very slightly in width to five-sixths the distance to the tip; first median nervure arising midway between the base of the wing and the second; the second midway between the origin of the second and third subcostal nervures; submedian nervure arcuate; internal short, straight, very obscurely connected with the submedian.

Hind wing a little longer than broad, the costal margin straight beyond the strong basal lobe; the outer margin well and regularly rounded as far as the middle of the medio-submedian interspace, below this distinctly though slightly lobed; the anal angle rounded, rectangular; the inner margin scarcely concave. Neuration as in *Anthomastix*.

Discal stigma of male consisting of, first, a longitudinal streak at base of middle median interspace, of shining, black, recurved rods; second, of a semilunar field of dead black erect rods in the lowest median interspace, overhung above by long, curving scales; followed below by a short, small striga of shining black scales, and outside by a large field of erect, loosely compacted scales. The scales in the stigma consist of short and slight jointed threads, the joints short and strongly fusiform, accompanied by large, spatulate scales and rods, and guarded at special points by two-pronged rods and long oval scales, while in the field below the stigma are found some large, apically fan-shaped scales, with deep, undulate margin.

Legs 2, 3, 1; under surface of femora and upper surface of tibiae furnished as in *Erynnis*; hind tibiae also supplied above with a thin, spreading fringe of long hairs. Femora 2, 1, 3; tibiae 2, 3, 1; tarsi 2, 3, 1; fore and hind femora of equal length, fully two-thirds the length of the middle femora; fore tibiae two-thirds the length of the fore femora, half as long as the middle tibiae, which in their turn are scarcely longer than the hind tibiae. Leaf-like appendage of fore tibiae not very large, long and slender, lanceolate, but the apical half curved, tapering and pointed, originating a little beyond the middle of the joint, surpassing a very little its extremity, about five times as long as broad; other tibiae armed at the tip with a pair of long and slender, very unequal spurs, the hind tibiae also with an exactly similar, scarcely shorter pair in the middle of the apical three-fifths; both tibiae have a lateral row of very infrequent, very long spines, as in the preceding genus. Tarsal joints 1, 2, 3, 4, 5, excepting on the fore legs, where the apical is a little longer than the penultimate joint; fore tarsi of the length of the middle femora, two-thirds the length of the middle tarsi, which are scarcely longer than the hind pair; all with a triple series of long and very slender spines, those at the apex of each joint fully twice as long as the others, excepting on the fore legs, where, however, they are much longer than the others; basal joint as long as the rest together on the middle legs, a little shorter than they on the others; second joint fully half as long as the basal. Claws not very small, delicate, tapering, regularly and strongly arcuate. Pad moderately large, quadrate. Paronychial bifid, the upper lateral lobe being compressed, laminate, falciform, pointed, as long as the claw, the other inferior, threadlike, half as long as the claw.

Abdominal appendages: Upper organ small, depressed, the centrum bent at right angles, beyond which all the parts are horizontal, the hooks very small and connate at tip, surpassed in length by the still slenderer, similarly connate, lateral arms which lie

just beneath them. Claspers broad and as long as the upper organ, equal, terminating at tip in a manner somewhat similar to the last genus.

Egg. Hemispherical, more than half as broad again as high, largest about one-sixth of the distance above the base, above that regularly domed with no flattening of the curve at the summit; minutely, profusely and uniformly punctate, the punctae being omitted only at the micropyle; covered with a polygonal network of raised lines.

Caterpillar at birth. Head large, shaped much as at maturity; with very distant, short bristles; surface smooth with very distant, faint punctures; ocelli six in number, the first five in a regular, arcuate, anterior series, the upper three equidistant, approximate, the lower three equidistant, distant; the sixth behind this series, forming a little more than a right angle with the first and fifth. Body very slender, equal; dorsal thoracic shield distinct, bearing anteriorly a transverse series of distant, apically enlarged, long, rather stout bristles, as long as the segment; abdominal segments of the body divided into five sections, the largest occupying the anterior half of the segment and marked posteriorly with a subobsolete crease, the posterior four subequal; bristles of the body wine-glass shaped, the apex being as broad as the basal papilla; they are scarcely more than half as long as the broadest section of the segment and are arranged as follows: a laterodorsal series in the middle of the broad anterior section; an infralateral series on the second of the short sections; a suprastigmatal series in the middle of the posterior half of the broad anterior section; and an infrastigmatal series, a pair to each segment, one a little in front, the other a little behind the middle, directed respectively anteriorly and posteriorly; on the last segment are two pairs of laterodorsal bristles as long as two or three segments of the body, erect but strongly recurved.

Mature caterpillar. Head stout, the lower half quadrangular, the upper broad, low, conical, deeply and rounded cleft at the median suture; of nearly equal depth throughout, excepting the narrowing, rounded summit above the neck; triangle obscure with a double median furrow; ocelli six in number, five in a strongly arcuate row, facing downward and forward at subequidistant intervals, the uppermost obsolete, the third and fourth largest, the fifth directly opposite the base of the antennae, the sixth above it and forming a right angle with it and the second.

Body long and slender, tapering more rapidly forward than behind, largest from the fourth to sixth abdominal segments; dorsal thoracic shield of equal width, extending almost to the spiracle, rounded at the extremity, a triangular part of which is nearly severed from the main body; deeply sulcate transversely, followed anteriorly by a naked space of equal width, in front of which the segment is abruptly narrowed to the width of the collar of the head; inferior gland of the first thoracic segment large, about as large as the basal joint of the thoracic legs, globose, transversely slit; segments of the body divided into seven sections, of which the first is the broadest and broader than any two of the others together, the remaining subequal, the spiracle situated on the second; covered profusely and pretty uniformly with minute papillae, having no serial disposition, bearing minute, excessively short hairs; the following series of crateriform disks: a lateral series on the fourth transverse fold, transverse, oval, minute; on the second and third thoracic segments these are situated a little lower, are double, one directly above the other and larger; on the second thoracic segment situated directly above the small thoracic callosity; a suprastigmatal series lying directly in the obsolete crease separating the first and second sections of the segments, broad, oval, transverse, slightly larger than the preceding, its length not equalling the width of the spiracles; an infrastigmatal series as far behind the spiracle as the suprastigmatal is in advance of it; and a lateroventral series of larger, circular ones on the first and second abdominal segments.

Chrysalis. Long, subcylindrical, the anterior extremity broad, a little depressed; head and prothorax together forming a broad mass nearly twice as broad as long with rounded sides, the middle half of the front forming an independent rounded projection; mesothorax a little broader than the prothorax, gently rounded above, scarcely

higher than the abdomen, slightly pinched laterally behind, the posterior curve parabolic; basal wing tubercles broadly rounded, not very prominent, the body behind them subequal as far as the end of the fourth abdominal segment; the fifth and sixth tapering slightly, beyond rapidly, to a point, which is formed by the cremaster; viewed from the side the body tapers slightly from the thorax backward to the extremity of the sixth abdominal segment, then more rapidly to a rounded tip which is interrupted by the projection of the hook-like, tapering, depressed cremaster; in front the body tapers rapidly from the middle of the mesonotum forward; the front rounded, a little produced, scarcely angulate in front of the eyes; prothoracic tubercles lateral, slightly raised, filled with a domed mass of bristles; fore legs reaching just beyond the tip of the antennae to the point where the median girth is placed; the middle legs shorter than the wing by about the length of a segment; the tongue projecting free to the tip of the fifth abdominal segment; abdomen supplied with a considerable number of minute tubercles ranged irregularly in six or seven transverse rows to each segment, each supporting a recumbent, backward directed hair; cremaster depressed, the sides oblique, expanded, broadly sulcate, their apex carinate, thus making a broad, deep, triangular sulcation on the upper surface of the cremaster.

So far as yet known, this genus comprises but one or two species, occupying a belt which traverses North America between the 27th and 41st parallels; one species has been found on the confines of New England.

The butterflies composing it are a little larger than those of most of the previously mentioned genera of this tribe; the fore wings of the male are furnished with a broad discal streak or spot which tapers outwardly to a point. The wings are colored and marked much as in *Erynnis*, but the females are more infuscated, so as to leave a very tortuous series of semivitreous spots crossing the outer half of the fore wings. They are remarkable for their appressed palpi. Little is known of the history of these insects, but they are probably double brooded.

The eggs are not very elevated, well domed, rather distinctly punctate. The caterpillars, pale green in early life, become gradually more and more dusky by their abundant sprinkling with griseous dots, so that when mature they appear almost uniformly fuliginous, with a black head. The chrysalids are also of a dark color with a lighter but speckled abdomen and long and slender cremaster; the head is slightly and roundly protuberant in front and the tongue reaches the end of the fifth abdominal segment.

EXCURSUS LXVIII.—FLIGHT IN BUTTERFLIES.

Over the grass,	Round about	Flow'r bells ring,
Hand in hand,	With the breeze,	With soft chime,
Kiss and pass,	In and out	Fairies sing,
Fairy Band—	'Neath the trees!	Keeping time—
On they go,	Steps so light	
Stepping soft,	Scarcely make	
Laughing low,	Dew-drops bright	
Kissing oft.	Gleam and shake!	

MARGARET DELAND.

THE mechanism of the flight of butterflies, as of all insects, is not altogether simple. The wings are broad expanses of membrane, supported at base by a more or less slender pedicel, which seems at first sight to have its

hinge at the very crust of the thorax ; the resistance of the air in their beats must be considerable, especially at the extremities of the wings, and all direct appliances for motion must be at the extreme base, under a highly disadvantageous leverage.

A close examination of the structure at the jointage will, however, show that a short arm of the lever does pass within the flexible walls of the sides of the thorax, and that the body wall above is more rigid and removed slightly nearer the centre of the body than the more flexible wall below the wing ; and two sets of vertical muscles will be found attached to this short arm, both, however, side by side on the under surface of the arm ; the inner set, however, is attached within, the outer set without, a point opposite the edge of the wall of the body above the wing. The inner set serves to raise, the outer, which hugs the wall of the body, to lower the wings.

Now while such an arrangement must, and as experiment shows does, have such an effect, it would seem as if it must work at a decided disadvantage and be quite inadequate to such rapid and powerful movements as are found in some insects ; in such, to give an example only among butterflies, as we see in the heavy bodied, small winged skippers ; or to give such a powerful rigidity to the wings when the insect is killed by prussic acid as will sometimes cause a wing to break in our endeavor to move it. Moreover if we dissect the body of any butterfly, we shall find the entire thorax crammed with muscles which have both their attachments on the walls of the thorax itself, one principal set running in an obliquely vertical, another in a longitudinal direction, and whose only possible use can be to flatten or shorten the thorax itself. Why such an apparatus to accomplish this ? Is it for respiratory purposes, as one may at first surmise ? But there are no such muscles, either as regards direction or tremendous power, in the abdomen where most of the respiratory openings occur. Apply experiment again and it is quickly seen that the action of the first set, the obliquely vertical muscles, which flatten the thorax, is to raise, of the other set to lower, the wings. These two entirely different agencies, one acting directly on the wing itself, the other indirectly, by the pressure of the edges of the body walls next the base of the wings, acting in unison, suffice to translate compound action into simple motion. Other special muscles serve for such other movements of the wings as are necessary. This will explain why the movements of the opposite wings are simultaneous and always absolutely co-ordinated : the more powerful muscles of the thorax cannot act upon the wings of either side independently of the opposite.

Comparative studies of the muscular appliances for flight in different butterflies have never been undertaken, but they might yield some interesting results, for the difference in the character of flight between most of the

Satyrids with their lazy, feeble action on the one hand, and of some Nymphalidae "flashing like lightning" as they pass by, or of most Hesperidae with their active bustling ways, on the other hand, is very marked. But wholly apart from the muscular force required, the form of the wing has a great deal to do with the character of the flight. Those which sail on expanded wings always offer an exceptionally broad expanse; the most rapid flyers have always a pointed apex to the fore wings, the lengthening of this part giving a greater leverage; those which may double suddenly in their flight never have the costal margin of the fore wings straight. And since the special form of the wing is characteristic of groups of greater or less size, so between the members of such groups the manner of flying is extremely similar.

It is thus that in the case of some mimetic Leptalids, the form of whose wings is altered to as great a degree as their coloring and pattern, their flight equally resembles that of their model; the changes have gone hand in hand and have given them an additional chance of life. It is not that they have wantonly or intentionally changed their mode of flight by imitation; those individuals whose wings were longest had perforce to fly a shade more like their models and had that better chance of freedom from attack which greater likelihood of a mistake on the part of their enemies would give them.

ATALOPEDES HURON.—The sachem.

[Velvet spotted skipper (Maynard).]

- | | |
|---|---|
| <i>Hesperia huron</i> Edw., Proc. entom. soc. Philad., ii: 16, pl. 1, figs. 1, 2 (1863);—Reak., Proc. ent. soc. Philad., v: 150 (1866). | <i>Atalopedes huron</i> Scudd., Syst. rev. Am. butt., 57 (1872). |
| <i>Pamphila huron</i> Kirby, Syn. ent. Lep., 690 (1871);—French, Rep. ins. Ill., vii: 159 (1878); Butt. east. U. S., 312-313 (1886);—Mayn., Butt. N. Engl., 60-61, pl. 8, figs. 94, 94a (1886). | <i>Isoteinon huron</i> Hew., Cat. coll. diurna Lep., 228 (1879). |
| | Figured also by Glover, Ill. N. A. Lep., pl. 38, fig. 9; pl. G, figs. 1, 2, ined. |

But at the window what comes in?
A lovely painted butterfly.

TAYLOR.—*The Morning's Task.*

Image (Fig. 16). Head covered above with dark greenish yellow and black hairs, the former in excess only in the ♂; beneath and behind the eye clothed with white scales, tinged slightly with yellow beneath, deepening above into tawny; the tuft on either side of the antennae of mingled tawny and black hairs. Palpi whitish at base, becoming more and more suffused with yellowish beyond the apical third to half pale lemon yellow, often tinged with tawny, or, in the ♀, interspersed with a few tawny scales; the extremity, viewed from above, of mingled dark greenish yellow and black hair-like scales; the apical joint is black above, and on the outer inferior edge of the middle joint is a row of black hairs; the inside toward the tip is somewhat infuscated. Antennae black, with purplish reflections above; beneath orange inwardly, and pale yellow outwardly, the colors all extending upon the club, but the brighter ones divided by a broad field of blackish or brownish fuscous, occupying the whole of the

under side excepting the basal third; whole crook blackish fuscous, the last joint black. Tongue very dark castaneous, growing blackish next the base, luteous toward tip.

Thorax covered above with olivaceous-tawny hairs, more or less mingled anteriorly with blackish ones; beneath with pale yellowish hairs, with a few intermingled blackish ones, and toward the sides becoming tinged with fulvous. Legs buff, deepest on the femora, which are yellowish beneath and fringed with fulvous hairs, and within are more or less infuscated, excepting toward the tip; the tarsi are a little dusker than the rest of the leg, and above, beyond the middle of the first joint, have a gradually broadening stripe of brown; spurs pale buff, tipped with dark reddish; spines reddish luteous; claws reddish; pad dusky.

Wings above tawny, bordered with dark brown (δ), or blackish brown, marked with pale tawny and white (φ). *Fore wings*: In the male the outer border is broadly margined with dark brown, occasionally flecked obscurely with fulvous scales, its interior border extending in a straight line at right angles to the costal border from the middle of the outer two-fifths of the costal border to the first inferior subcostal nervule; here it is removed half the distance which would otherwise separate it from the outer border until it reaches the upper median nervule, when, at a similar distance from the margin to what it first occupied, it passes in ill-defined crenulations, the outer points of which approach the margin on the nervules, to the inner border; the two interspaces beyond the tip of the cell are partially occupied by a quadrate or triangular dusky spot, larger above than below, extending above as far outwardly as the middle of the excision in the outer bordering of the wings, vaguely limited interiorly, and reaching at least halfway from its exterior limit to the tip of the cell. Stigma (43:11) formed principally of a large, slightly arcuate, subconical patch, reaching from the second divarication of the median nervule, where it is pointed, to, or very close to, the middle of the basal two-thirds of the submedian nervule, where it is broadly rounded; its upper border is convex and follows the median nervule to midway between its base and last divarication, and then suddenly bends to the submedian; the under border is concave and sweeps with a regular curve to the submedian nervule, causing the patch to broaden regularly and inconsiderably on its outer half, more rapidly on its inner half; the outer half of its upper edge is occupied by a slender stripe of velvety black made of closely compacted hairs, and a small, similar, oval patch, seldom more than half as long, occupies its border next the submedian nervule; these are sometimes connected by a line of velvety black following the upper limits of the whole patch; the upper inner half of the remainder is filled with elongated, loose brown scales, directed toward the deepest part of the concavity of the exterior border; the remainder with a dirty grayish substance; the patch is followed outwardly by a large roundish field of erect, fuliginous, black scales, the interior margin of which rests against the whole of the exterior border of the principal patch, excepting the outer velvety part, and which is a little longer than broad, equal parts lying on either side of the lowest median nervule. The costal and submedian nervures are broadly bordered on the basal fourth or fifth of the wing with brownish scales, and the nervules on the apical half of the wing are delicately traced in brownish; the costal edge is sometimes brownish, and the outer edge delicately marked with blackish; fringe of mingled tawny and dark brown, the latter absent below the lowest median nervule. In the outer half of the wing of the female is an irregular series of pale spots made up, first, of a transverse row of three subequal small, contiguous spots, separated only by the nervures and thus forming a single small quadrate patch, half as long as high, at about right angles to and just outside the middle of the outer half of the costal border, which it does not attain; the spots are whitish, the upper one tinged with tawny; second, of a curving row of four unequal, quadrate or angular spots, generally pale tawny, sometimes whitish, the two smaller equal and square, the upper of them slightly outside of the lower, situated in the interspaces lying beyond the cell, their exterior limits separated from the outer border by the width of an interspace and a half, the two larger whitish, occasionally pale tawny, rhombic or subrhombic in form, the upper of them broader apically than basally, its lower outer angle often considerably produced, situated close to the base of the upper

median interspace, the lower in the lower median interspace, with its interior margin rounded, its exterior reaching to the interior margin of the upper spot; in addition to these spots, the outer third or half of the cell is dashed with pale tawny, and the base of the interspaces beyond the cell as well as the whole basal half of the costal border is flecked more or less with tawny; the brown submedian nervure is narrowly edged with pale tawny, which toward the middle of the wing expands on either side into a vague patch, more or less triangular above; the outer edge is delicately traced with blackish; fringe dusky, becoming paler below the lowest median nervure. *Hind wings* dark brown; in the ♂, they are lightly flecked next the outer border with a few tawny scales and the whole disc between the subcostal and submedian nervures suffused with tawny, but traversed by dusky nervures, and beyond the middle of the wing (excepting at the submedian nervure, on which a tawny, longitudinal streak extends quite to the outer border) powdered rather sparsely with fuscous scales, which renders the inner limits of the darker outer border obscure; this is sinuous, approaching the outer margin beyond the cell to within less than the width of an interspace, receding from it in the medio-submedian interspace; the inner third of the wing is largely provided with tawny hairs. In the ♀ the darker color is more uniformly spread over the surface, but tawny hairs are found over the whole inner half and even at the centre of the wing, while a transverse, slightly irregular, moderately broad band of tawny, broken by the dusky nervures, crosses the middle of the outer two-thirds of the wing from the upper subcostal to the lowest median nervures; excepting the portion in the subcostal interspace, which lies within the parts following, its exterior limit on a line with their interior limits, the band lies at right angles to the inner border, gradually receding from the outer border as it approaches the latter; there is, also, a small spot or dash of tawny in the cell, next to and between the divarications of the median nervure. The fringe is tawny, paler and dingier in the ♀ than in the ♂.

Beneath saffron colored, the upper half of the fore wings tinged with tawny, all excepting the tawny parts frequently obscured in large measure by fuscous. In the ♀, as is also the inner border of the fore wing as far as the submedian nervure, and the lower half of the base in the ♂; the outer border of both wings and at least the outer half of the costal border of the fore wings are delicately edged with blackish and the fringe is similar to that of the upper surface but a little brighter. *Fore wings*; the markings of the upper surface are repeated beneath in the ♂, very indistinctly, and the discal patch not at all; a few pale spots represent the similar ones on the ♂ above the median area; in the ♀ distinctly of a similar form and size as above, excepting in the tawny patches of the cell and of the submedian nervure, the former of which is merged in the general tawny tint of the cell, the latter, greatly diffused, extending as a broad, pale, obscurely limited patch in the outer half of the medio-submedian interspace, and which is also represented, inconspicuously, in the ♂ by a paler yellow than the ground. *Hind wings*; the obscurity of the markings in the male is in perfect accord with that of the fore wings, so that it is only in flown specimens that one may distinctly make out that the limits of the paler and clearer transverse band is similar to that of the female. The markings of the upper surface of the female are rather obscurely repeated beneath, sometimes as obscurely as in the ♂, the transverse band being not infrequently extended by a squarish spot, occupying the whole width of the costo-subcostal interspace, as far removed inwardly from that of the subcostal as that is from the lower portions of the band; occasionally the whole band is bordered by dark interspaceal spots; the inner margin is clearer than the rest of the wing in both sexes.

Abdomen blackish, largely obscured, especially on the sides and on the apical half of the segments with tawny; beneath pale yellow, almost white. Upper organ of male abdominal appendages (37-21, 22) with each of the hooks twice as long as broad, incurved, very blunt tipped, scarcely half so long as the horizontal portion of the centrum. Claspers nearly two and a half times longer than broad, the upper and lower borders straight, the former with a slight prominence in the middle; lower half of the clasp produced to an abrupt, upcurved and slightly incurved, tapering process, its tip passing

a little above the upper border and its edge forming the posterior border of the clasp; upper posterior angle of clasp slightly produced, a little incurved and bearing at its extremity a fine upturned thorn, lying beside the extremity of the lower process.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 12.2 mm.						
Length of fore wing.....	14.5	16.5	17.5	17.	19.25	20.
antennae.....	6.5	7.25	8.	5.	7.5	8.
hind tibiae and tarsi...	7.6	8.5	9.	8.5	9.2	9.8
fore tibiae and tarsi...	4.75	5.5	6.	5.2	5.9	6.4

Described from 8 ♂, 12 ♀.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wings; the scales contained in it consist of jointed threads, the joints (49:3 d) short, strongly fusiform in the heart of the stigma, accompanied, at least in the basal patch, by some spatulate scales of peculiar form, either very large with a large spatula developed from a broad shank (3 c), or of long, feebly spatulate rods (3 g); guarding these androconia are found at the extreme base two-pronged rods of very varying lengths (3 f, k), accompanied above by large, very elongated, oval scales with entire margins, with converging waved reflections at tip (3 a), and along the upper edge two-pronged and three-pronged, slender, rod-like scales, enlarging rapidly though not greatly at their base (3 b, h); in the field below the stigma are found some scales of very peculiar form (3 e); they are large, equal and rather slender in the basal two-thirds, suddenly expanded into a fan-shape apically, the outer margin strongly convex and deeply waved. In the vitreous spot of the lower median interspace of the female are found some rounded subquadrangular scales with waved reflections and entire margins (3 i).

Egg (66:31). The cells of the reticulation quadrangular, half as broad again as long on the basal half of the egg, above which they are at first of about equal height and breadth and irregularly pentagonal, afterward, and soon above the middle, higher than broad; at the base the cells are about .042 mm. in length, in the middle about .03 mm.; at the summit where the longer axis is vertical it is of about the same length; the micropyle (69:11) consists of a collection of radiately arranged minute cells, together forming a cluster only .042 mm. in diameter, immediately surrounded by pentagonal cells scarcely smaller than those at some distance from the micropyle. Diameter, .9 mm.; height, .56 mm.

Caterpillar. First stage (77:28). Head (80:68) blackish castaneous, the sutures black; ocelli pellucid in a dusky field, darkest inferiorly; mouth parts generally infuscated; dorsal thoracic shield dark castaneous, edged with black on all sides. Body pallid, with a tinge of greenish, the bristles pellucid; first pair of thoracic legs blackish fuscous, the others concolorous with the body; the claws and tips of the last joint blackish; prolegs concolorous. Length, 2 mm.; breadth of body, .4 mm.; of head, .5 mm. Described from specimens in glycerine.

Second stage. Head (80:69) piceous, finely punctate; all mouth parts blackish fuscous. Body very pale yellowish green; dorsal thoracic shield piceous, the transverse furrow testaceous; papillae and their very short bristles blackish fuscous, not very numerous. Length, 4.5 mm.; breadth of body, .8 mm.; of head, 1 mm. Described from specimens preserved in glycerine.

Third stage (77:30). Head piceous, with a faint greenish tinge, rather profusely and distinctly punctate; dorsal thoracic shield blackish fuliginous, the transverse furrow blackish; first pair of thoracic legs blackish fuscous, other pairs fuliginous; prolegs concolorous with the body; body as in preceding stage. Length, 8 mm.; breadth of body, 1.5 mm.; of head, 1.5 mm. Described from specimens preserved in glycerine.

Fourth stage. Head (80:70) black, the base between the ocelli and mandibles with a lutescent cloud; the surface deeply punctate, the punctae more or less run together in rudely vertical lines; dorsal thoracic shield blackish fuscous; the segment in front of

It at first pallid, next the collar of the head pinkish fuscous; first pair of thoracic legs blackish castaneous; the fleshy basal joints and the inferior surface of the first coxae joint discolored, like the anterior part of the segment above; second pair of thoracic legs with the three apical joints slightly lighter in color than the first pair; the third pair with the apical joint and apical half of the penultimate joint like the second pair of legs; the rest of the second and third pair of legs, like the prolegs, concolorous with the body; thoracic spiracle blackish fuliginous; other spiracles pallid, with a fine testaceous rim; rest of body as in previous stages. Length, 20 mm.; breadth of body, 2.5 mm.; of head, 2.25 mm. Described from a blown specimen.

Last stage (77:34). Head (80:71) as in previous stage, but with the luteous cloud of the under surface of head more distinct and extended, and in addition there is on either side of the median furrow above the triangle a narrow, vertical, fusco-luteous streak; mouth parts testaceous; the tip of the sides of the labrum luteous; the edges of the mandibles blackish; the labial apparatus pale luteous.

Body pale green, more or less clouded with darker fuscous green, profusely sprinkled with excessively minute blackish fuscous papillae, each bearing an excessively short, fulvous hair; dorsal thoracic shield black, transversely cleft along the mediodorsal line, and just above its termination at the sides incised and partly severed by pallid papillae, the transverse furrow dull, dark castaneous; it is edged in front by a naked, pallid band, of equal width, in front of which, at the greater constriction of the segment, the surface is much discolored, as also beneath over the whole segment; the last three joints of all the thoracic legs blackish, the antepenultimate of the third pair less conspicuously; prolegs and base of thoracic legs concolorous; all the spiracles black; annuli of the crateriform disks blackish fuscous. Length, 40 mm.; breadth of body, 6 mm.; of head, 3.75 mm. Described from blown specimens.

Chrysalis (85:43, 47). Dark reddish brown, the thorax and wings nearly uniform, the head with three large, round, luteo-fulvous spots, arranged triangularly, one occupying the most prominent part of the front, and two lying side by side between the basal joints of the antennae; the mandibles and all the incisures are also of the same color, as are also the ocellar ribbon and the parts immediately around it; abdomen, excepting the basal joint, which, like the metathorax, is of the same color as the mesothorax, testaceous, probably more or less greenish in life, much mottled in a regular fashion with blackish fuscous spots, which are most abundant on the dorsal parts, and often merge; among them is a large, transverse, lateral spot placed in advance of the middle, two or three suprastigmatal spots, often merging, a curving, infrastigmatal spot and a series of ventrostigmatal central dots; cremaster luteo-castaneous, infuscated along the carinae; hooklets confined to the extreme tip, castaneous. Length, 21 mm.; height, 5 mm.; breadth of head, 4.25 mm.; length of cremaster, 2 mm. Described from dried specimens.

This species is considered by some as identical with that described from California by Boisduval under the specific name *campestris*. This may prove to be the case, but the specimens of the two which I have seen will not permit such a conclusion, and they are therefore here regarded as distinct.

Distribution (31:1). This is a wide spread species of the Carolinian fauna, where it is found in the greatest abundance from Florida (Maynard, Chapman, Palmer, Wittfeld), South Carolina (Scudder) and West Virginia (Edwards), to central Texas (Boll, Belfrage), southern Texas next the Rio Grande (Aaron, Lintner), New Mexico (Aaron) and eastern Kansas, abundant (Snow). But it extends beyond our territory, for, though known in Florida only as far south as Brevard County (Wittfeld),

it occurs in various parts of Mexico, as at Putta and also at Saltillo and San Luis (Pahner). To the north it has been found from Colorado (Mead, Reakirt), Fort Niobrara, Neb. (Carpenter), northern Illinois (Worthington), Cleveland, Ohio, common (Kirkpatrick), to the Catskills, N. Y. (Edwards), which is the nearest point to New England at which it has been taken. This was many years ago, and it has not been noticed since.

Food and habits of caterpillar. Dr. Wittfeld says that the larva feeds on Bermuda grass, *Cynodon dactylon* Pers., and fastens together a number of blades, spinning in the cylindrical cavity thus formed a silken web and living within the retreat, coming out only to feed. It grew to maturity in southern Florida in twenty-seven days, passing the first moult in five days after birth, the second, third and fourth in four, three and five days, and remaining in the final stage eight or nine days.

Life history. The data concerning its apparition, which are very few, merely indicate that it is triple brooded, the generations appearing in April, July and September. The eggs hatch in from three and a half to four days in southern Florida (Wittfeld), or four days in West Virginia (Edwards), and all the preparatory stages are passed, according to Dr. Wittfeld, in forty-one days, the chrysalis continuing ten days in August.

Desiderata. Although little remains to be done upon the structural features of this insect, our knowledge of its habits, whether in the caterpillar or imago state, is nearly a blank; the life history is very vaguely indicated above, and its relation to the allied *A. campestris* of the Pacific coast is yet to be made out carefully. A more perfect knowledge of its western distribution would be the first thing to be gained.

LIST OF ILLUSTRATIONS.—*ATALOPEDES HURON*.

General.	<i>Chrysalis.</i>
Pl. 31, fig. 1. Distribution in North America.	Pl. 85, fig. 43, 47. Chrysalids.
<i>Egg.</i>	<i>Imago.</i>
Pl. 66, fig. 31. Egg.	Pl. 17, fig. 8. Female, half of upper surface.
<i>Caterpillar.</i>	16. Male, both surfaces.
Pl. 77, fig. 28. Caterpillar at birth.	37:21. 22. Male abdominal appendages.
30. Caterpillar in stage III.	42:11. Neurulation.
31. Mature caterpillar.	43:11. Discal stigma of fore wing of male.
80:68-71. Front views of head in stages I, II, IV, V.	49:3. Scales of the discal stigma.
	59:6. Side view of head and appendages enlarged, with details of leg structure.

ANTHOMASTER SCUDDER.

Anthomaster* Scudd., Syst. rev. Amer. butt.,
67 (1872).

Hesperia pars Auctorum.
Pamphila pars Auctorum.

Type.—*Hesperia leonardus* Harr.

The wind-rows are spread for the butterfly's bed,
And the clover-bloom falleth around.

ELIZA COOK.—*Song of the Haymakers.*

Imago (59: 7). Head very large, heavily clothed above with not very long hairs mostly arranged in transverse masses; outside of the antennae there is a thin, compressed, spreading tuft of arcuate bristles, inclined a little forward, and passing less than one-third way over the eye. Front protuberant, extending, excepting at its upper extremity, some distance beyond the front of the eyes, rather tumid, most so just below the middle when viewed laterally, and at the middle viewed from above, regularly and considerably arcuate from side to side; a transverse, rather sharp and prominent ridge, which turns a little upward at its extremities and terminates at some distance below the inner edges of the antennae, the whole piece about two and one-fourth times as broad as long, the front border broadly rounded, a little straightened in the middle, terminating at the outer edges of the antennae; it is separated from the vertex by a straight, slightly impressed line connecting the middle of the antennae. Vertex only slightly arcuate longitudinally, scarcely reaching the level of the eyes, separated from the occiput, which is sulcate in the middle longitudinally, by a slightly impressed, regular, brace-shaped line. Eyes pretty large, pretty full, nearly circular, naked. Antennae inserted with their hinder edge scarcely behind the middle of the summit, separated from each other by scarcely three times the width of the basal joints, the whole antenna somewhat shorter than the abdomen, consisting of thirty-six joints, of which seventeen or eighteen form the club, which is either about one-third the length of the stalk, the crook consisting of three minute joints rapidly tapering to a point, forming altogether an insignificant portion, scarcely longer than broad, and about one-third as long as the breadth of the club; the latter, exclusive of the crook, is stout, oval, a little compressed, scarcely four times as long as broad, broadly rounded at tip, tapering at base, largest scarcely beyond the middle when viewed laterally, in the middle of the apical half when viewed from above (♂); or, about one-fourth the length of the stalk, the crook consisting of four joints, but in intimate continuation of the narrowing apical joints of the club proper, the last nine joints of the whole tapering regularly and rather rapidly to a point; this portion being nearly twice as long as broad, while the other extremity of the club tapers more gradually and the whole club is largest in the middle, whether viewed laterally or from above, and is five times as long as broad (♀); middle joints of the stalk three times as long as broad, the third from the base of antennae four times as long as broad. Palpi rather short and very stout, flattened in front a little obliquely, nearly or quite twice as long as the diameter of the eye, clothed very compactly with a very heavy mass of not very long scales, beyond which the terminal joint, clothed pretty heavily but only with recumbent scales, is scarcely visible; basal joint bullate, greatly expanded at tip, with a tumid extension on the inner side fully as broad as long; middle joint large, bullate, broad, obovate, laterally considerably arcuate, twice as long as broad, scarcely broader than the basal joint, somewhat larger than the diameter of the eye, equally and broadly rounded at either end; apical joint seated a little outside the middle of the anterior border of the extremity of the middle joint, nearly cylindrical but slightly largest in the middle, with both ends bluntly rounded, straight, its length about three and a half times greater than its width and about three-fourths the width of the middle joint.

Prothoracic lobes pretty large, appressed, laminate; viewed from the front they are

**άνθος*, *μαστίχ*, flower seeker

subtriangular, the inner edge straight and at right angles to the lower slightly convex edge; the upper outer edge is considerably arcuate and the whole piece half as long again as broad and as long as the longer diameter of the eye. Patagia pretty large, four-fifths as long as the width of the head, the posterior lobe considerably less than half as broad as the base, but longer than it, straight, equal until near the tip, where it tapers to the rounded extremity.

Fore wing (42: 15) a little (δ) or considerably (φ) less than twice as long as broad, the lower outer angle slightly outside the middle of the costal border; costal margin straight beyond the slightly arched base, the outer margin slightly convex above the medio-submedian interspace, the apex considerably produced (δ), or considerably convex throughout, the apex scarcely produced (φ). Costal nervure terminating at the middle of the costal margin; subcostal nervure moderately approximate to the costal margin; the third nervure originating just beyond the middle of the wing; cell about three-fifths the length of the wing, slender and in apical half equal; second median nervure arising opposite the base of the third subcostal nervure, the first midway between it and the base; internal nervure rather brief, running into the submedian.

Hind wing scarcely, if at all, longer than broad, the base of the costa strongly lobed, costal and inner margins of about equal length from the length of the subcostal area; outer margin well rounded, with a slight, submedian, rounded lobe, scarcely perceptible in the female. First median fork distinctly more distant from the base than the first subcostal and only a little beyond the basal third of the wing.

Discal stigma of male closely resembling that of *Erynnis*. The scales consist, in the heart, of jointed threads with long fusiform joints of large size, and of subspatulate rods; at the base and apex, of pronged or truncate rods or scales; and in the field below the stigma of large scales, generally enlarging apically and with entire margins and fine striae.

Legs 2, 3, 1. Under surface of femora and upper surface of tibiae clothed as in *Atalopedes*, but the upper surface of the middle and hind tibiae still more abundantly furnished with conspicuous spines. Femora 2, 1, 3; tibiae 2, 3, 1; tarsi 2, 3, 1. Fore and hind femora three-fourths the length of the middle pair. Fore tibiae two-thirds the length of the fore femora, which is but little shorter than the middle and hind tibiae. Leaf-like appendage of fore tibiae small, not so slender as in the previous genera, originating in the middle of the apical two-thirds of the joint, scarcely surpassing its extremity, four times as long as broad, equal until near the tip, where it tapers to a point and is somewhat curved. Other tibiae furnished at tip with a pair of exceedingly long and slender unequal spurs, the hind tibiae also with a secondary, scarcely shorter, similar pair just before the middle of the apical two-thirds, both tibiae with lateral spines in *Atalopedes*. Tarsal joints 1, 2, 3, 4, 5; fore tarsi a little more than three-fourths the length of the middle, four-fifths the length of the hind tibiae, a little longer than the middle femora; all furnished with a triple row of long and slender spines, those at the apex of the joints somewhat longer; basal joint as long as the second, third and fourth together; second about half as long as the basal. Claws pretty small, delicate, tapering, pointed, pretty strongly and regularly arcuate. Pad small, transverse. Paronychial bifid, the upper lobe a large, broad, compressed, ensiform plate, as long as the claws, its lower border nearly straight, its upper curving like the claw; lower lobe a minute, triangular, very inconspicuous projection.

Male abdominal appendages: Upper organ pretty large, strongly curved, appressed, tapering, convex transversely. Centrum strongly arched near the middle, beyond which the parts are nearly horizontal; hook single, depressed, regularly tapering; lateral arms connate, similar to the hook, but much slenderer and curved in an opposite direction. Clasps large, as long as the upper organ, broad, convex, tapering a little, terminating in a rounded lobe bearing an upturned, pointed tooth.

Egg. Pretty high, broadest at the base, narrowing regularly but not greatly to the summit, which is broadly rounded and a little flattened; under surface, and incon-

spicuously the upper surface also, broken by delicate raised lines into a series of pentagonal and hexagonal cells. .0127 mm. in width.

Caterpillar at birth. Head very large, globose, pyramidal. Dorsal thoracic shield moderately broad, broadest in the middle, extending interruptedly by the aid of a transverse, somewhat lunate piece to the stigmata. Body slightly largest in the middle, gently tapering toward either end; furnished with several series of minute papillae supporting long, straight, wine-glass shaped bristles arranged as follows: a laterodorsal series, one to a segment, placed in the middle of the anterior half and erect; a lateral series post-central, one to a segment, the bristles directed forward; a supra-stigmatal series, one to a segment, placed anteriorly and erect; and an infrastigmatal series, two to a segment on either side of the middle.

This genus, with a single species, is a characteristic Alleghanian type; it occurs in the southern half of New England, sometimes in abundance, rarely in the northern portions.

The butterflies are similar in size to those of *Atalopedes*, or even slightly larger, and are the largest of this tribe found in New England, excepting the tropical *Calpodus* and the southern *Phycanassa*. The males are furnished with a discal streak on the fore wings, similar to that of the genus *Erynnis*. Above, the wings are tawny, obscured with dusky and broadly bordered with dark brown in the male, dark brown tinged with tawny at the base and with a transverse, extra-mesial, tawny band in the female. Beneath, the wings are much darker, with a pale, extra-mesial band.

The butterflies are swift and strong of flight and are single brooded, hibernating as caterpillars while still quite young and only appearing on the wing late in the season—toward the end of August. Beyond this, their history is imperfectly known. They love the hottest sunshine and mingle in companies on autumn flowers.

The eggs are large, domed and high, of a chalky white. The caterpillars at birth are slender, pallid, with a black head and thoracic shield; dorsal appendages less than half as long as the segments, and some long, recurved hairs behind longer than the segments; after the first moult they at once become flecked with black dots, but the later changes are unknown.

EXCURSUS LXIX.—BUTTERFLY VISION.

Little fly,
Thy summer's play
My thoughtless hand
Has brush'd away.

If thought is life
And strength and breath,
And the want
Of thought is death;

Am not I
A fly like thee?
Or art not thou
A man like me?

Then am I
A happy fly,
If I live
Or if I die.

For I dance,
And drink, and sing,
Till some blind hand
Shall brush my wing.

WILLIAM BLAKE.—*The Fly*.

VISION in insects with compound eyes has been a subject of discussion for very many years and the opinions of naturalists regarding it have differed from time to time very considerably. The question has recently

received much new light from the anatomical investigations of Patten and others and the experimental researches of Forel and Plateau. The compound eyes of butterflies, as of other insects, are made up externally of a number of adjoining hexagonal facets, each separate facet being the exposed portion of a crystalline lens which is followed beneath by a slender tube containing, first, a terminal body, the crystalline cone or retinidium, formerly looked upon as a second refracting medium, but by Patten regarded as a retinal body sensitive to the light; and, second, of a collection of rods. The office of this so-called crystalline cone is the principal point in dispute. The later researches regard it as a receptacle for the termination of the nervous elements, and as performing no office in either modifying or destroying the image: while the old view regarded it as having similar properties to the crystalline lens of our own eye. Now if the later view be regarded as correct, the form and nature of this receptacle is such, as Plateau points out, that an image may be formed at any point within its depth, but that at the same time all the sensitive points of the cone in advance of or behind an image will be illuminated and will also to some degree be excited by the same object, so that whatever image is formed can in no way be seen as distinct but only as entirely confused; much as happens in the human eye when the image is focussed beyond the retina.

This theoretical view can be perfectly well subjected to experiment, and this has been done in the most thorough manner by Plateau. At first his experiments were made almost entirely by placing the insect desired to be experimented upon at one end of a closed compartment at whose other end were two distinct openings to the light, one simple and large enough for the escape of the insect, the other much larger but covered with a trellis or grating, forbidding passage; so that while the actual superficial area of the open spaces might be the same in each case, admitting the same quantity of light, the trellised opening would appear greater. The insects almost invariably flew to the latter. At the same time one could modify at will the amount of light which would enter either of these two different classes of openings. Numerous experiments were made by Plateau upon this basis, resulting in his conclusion that insects with compound eyes did not well distinguish between two illuminated openings, being sometimes led astray by the excess of luminosity, sometimes by the apparent excess of surface. In general they could not distinguish the form of objects or only in a vague way.

Objections were raised that in these cases it was not objects but luminous openings, the power of seeing the form of which was tested; and also that the judgment of the insect was brought into service under unnatural conditions, so that the experiments proved nothing definite and decisive regarding the actual power of visibility on its part. Thereupon Plateau devised a new method by which experiments could be

made, obviating all these objections, and has carried out these experiments even more carefully and extensively than the previous, instituting, moreover, comparative investigations with the vision of vertebrates under precisely similar circumstances. To do this he constructed what he has termed a labyrinth, a table covered with a large number of vertical barriers placed in concentric series in such positions that the creature must take a very circuitous course among them to escape. Of course only crawling insects could be experimented on, but the structure of the eyes is essentially the same in all. Care was taken that the coloration of the surface should be of a neutral tint and the vertical barriers were painted of various colors, white, brown or black: also that the animal should begin its movements without excitement, by the quiet lifting of a glass cover under which it had been placed, when it would find itself surrounded by walls between which were abundant passages. Where the vision was really good, the animal would be expected to move in a serpentine course between the obstacles, never striking them, usually moving toward the opening which was largest or nearest. When, however, the power of vision was to some extent defective, so that the animal seemed to be aware of the existence of an obstacle only when it had almost reached it, then the movements should be made in a series of zigzags which would change direction somewhat sharply, shortly before the barrier was reached. Or if the vision were absolutely defective, the creature would be likely to find its way only by first striking the objects and then moving around them.

The result of his experiments proved that vertebrates had complete vision, directing their movements with ease without striking any of the obstacles, moving in the nearest path; while insects acted in all cases as if they had a veil before their eyes, their change of direction before reaching the barrier being such as to indicate that it was only when they reached the shadow of the obstacle before them, when they could distinguish some difference in the intensity of light, that they turned aside to avoid such an obstacle. The result of these experiments has been so uniform and so clear that, however the actual anatomical structure of the eyes of insects may be regarded, there can be little doubt that their vision is so extremely imperfect that they perceive sharp images of nothing immobile, and, therefore, do not distinguish the precise form of objects, though they can readily distinguish objects in motion; indeed they are particularly keen in this sort of vision, so that their sight must be best while upon the wing; and this at once explains the tremulous movement of the *Lycaenidae* before alighting on an object, for of all butterflies these, as Plateau's special experiments show, have the poorest vision, being disturbed by a moving object only when at half the distance at which a *Nymphalid* would take alarm.* So too, they can distinguish masses of color

* It should also be noticed that the *Lycaenidae* have, of all butterflies, relatively the smallest visual surface on the ocellar globe, being hardly half that of some.

but not pattern except in the vaguest way. The comparative experiments revealed an enormous difference in the behavior of vertebrates and insects under precisely identical circumstances; the former acting as if they possessed human vision, the latter as if they could distinguish the form and boundaries of objects in a most imperfect way, at the best.

"A flying insect," says Plateau at the conclusion of his various experiments, "has a very lively perception of light and shadow, so that without distinguishing as we would do all the details of its route, it knows how to avoid all masses such as the trunks of trees, bushes, rocks, walls, etc., and passes them at a convenient distance. Caught from any cause in a mass of shrubbery or any other group of vegetation, it takes advantage, when it wishes to pass on, of those passages through which the greatest amount of light filters or, as between two equal in this respect, of such as seems to it to offer the most room. If the wind move the leaves, these openings may oscillate, but thanks to its good perception of movements, the insect can then see them better. In flying, the insect moves in undulations so as to follow the direction of the displacements and to traverse the openings without striking.

"When its mode of sustenance necessitates a visit to certain flowers, it moves toward them either with certainty, in being guided by its sense of smell only, if its power in this direction is well developed; or by chance, if its olfactory powers are relatively slight. Incapable of distinguishing by their forms flowers of the same color, it goes directly toward the colored spots which to it mean corollas or inflorescence, turns, hesitates, and does not decide what to do until the distance has become sufficiently slight to enable it to determine by the odor whether or not it has found what it seeks.

"The sense of smell only or this combined with visibility of movements assures the meeting of the sexes, and finally it is the perception of movements which warns of the approach of an enemy and permits escape in time.

"This brief statement is sufficient to show how an insect with faceted eyes, though it only has a confused visual perception of objects at rest, frequently acts in a manner to suggest to one who does not closely analyze the phenomena that the eyesight of these creatures is as distinct as that of the vertebrates."

The consequences of such a conclusion are far-reaching. It follows that the whole structure upon which the theory of sexual selection in insects has been based is at fault, and it supports the objections to it which Wallace has brought on other grounds. It shows that the recognition of the food plant by the mother, which does not and cannot taste it, must be by some other sense than that of sight. And it becomes clear that

the exquisite beauty and variety in the butterfly world is not recognizable by themselves and forms no element in their lives.

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ANTHOMASTER LEONARDUS.—Leonard's hesperid.

[Leonard's skipper (Harris); Leonard's hesperid (Seudler).]

- Hesperia leonardus* Harr., Ins. Inj. Veg., 3d ed., 314-315, fig. 138 (1862);—Morr., Syn. Lep. N. Amer., 110 (1862).
Pamphilus leonardus Kirb., Syn. Cat. Lep., 509 (1871);—Fern., Butt. Me., 97-98 (1884);—French, Butt. east. U. S., 319 (1886);—Mayn., Butt. N. Engl., 61, pl. 8, figs. 95, 95ab (1886).
Anthomaster leonardus Seudl., Syst. rev. Am. butt., 57 (1872).
Iseion leonardus Hew., Cat. coll. diurn. Lep., 220 (1879).
 Figured also by Glover, Ill. N. A. Lep., pl. 23, figs. 7, 8, ined.

Child of the sun! pursue thy rapturous flight,
 Mingling with her thou lov'st in fields of light;
 And, where the flowers of Paradise unfold,
 Quaff fragrant nectar from their cups of gold.
 There shall thy wings, rich as an evening-sky,
 Expand and shut with silent ecstasy!
 —Yet wert thou once a worm, a thing that crept
 On the bare earth, then wrought a tomb and slept.
 And such is man; soon from his cell of clay
 To burst a seraph in the blaze of day!

ROGERS.—To the Butterfly.

Imago (10: 12, 14; 13: 11). Head covered above with olivaceo-tawny hairs, with a few intermingled black ones, more abundant in the ♀ than in the ♂; the scales below and behind the eyes scarcely paler, excepting in the ♀; the tuft at either side of the base of the antennae orange, mingled next the antennae with a few black bristles. Palpi fulvous, paler below, gradually deepening toward the apex, where, and on the outer surface, it is considerably tinged with orange; a few black bristles are found at the tip and along the outer front edge of the middle joint; apical joint black above; antennae blackish above, laterally inflexed upon by tawny, especially at the base of the club where the black is wholly supplanted; beneath pale yellow with a greenish tinge, deepening to tawny next the black; club and crook above black, the tip of the club portion dull castaneous; anteriorly the club is tawny, beneath pale silvery yellow on the basal half, beyond naked and dull castaneous, the apical joint of crook black. Tongue black, the extreme tip dark castaneous.

Thorax covered above with greenish tawny, beneath with olivaceo-buff hairs, often tinged, especially in front, with tawny. Legs reddish buff, rather pale beneath, the legs blackish within; the fringes of the femora of the color of the surrounding hairs; leaf-like appendage of the fore tibiae dull, reddish buff; spurs pale buff, tipped with dark red; spines dark red, growing a little darker on the apical joints of tarsi; claws dark red; paronychial fuliginous; pad dusky.

Wings above dark brown, with a mulberry tinge, particularly in the ♀, marked with dark and pale tawny. Fore wings furnished in the middle of the outer half with a broken,

curving series of pale tawny spots, usually paler in the female than in the male, extending from the costal border to the submedian nervure; it consists, first, of a set of three, occasionally four, closely connected longitudinal, equal spots, depending at about right angles from a little beyond the middle of the outer half of the costal border, forming a common spot fully half as broad as long, divided by the dark nervules; second, of two minute, roundish, or lunate spots just beyond the middle of the interspaces beyond the cell; and third, of a set of four irregular, varying spots, the general outer limit of which runs subparallel to the outer border at fully two interspace's distance from it; the upper spot, at the base of the upper median interspace, is triangular and usually distinct in both sexes; the others are distinct only in the ♀, where that in the lower median interspace is squarish, its middle just below the inner limit of the spot above; while that in the medio-submedian interspace is double, irregular and variable in shape, but nearly always constricted in the middle of the interspace, and more or less regularly expanded above, the lower portion tending to lie nearer the base than the upper; these spots, in the ♂, not only have their outer margin more obscurely defined than in the ♀, but their inner border is wholly lost, since the spots merge in the tawny colors of the whole middle of the wing; for in this sex the whole base of the wing is dark tawny, occasionally so far as to include also the upper spots of the series just mentioned, but excepting always the interspaces beyond the cell, and generally, also, the part lying directly above them, although the latter often shows lines of tawny between the dark nervules; within this space the nervures are delicately marked with dark brown, and the nervures in the basal fourth broadly bordered with the same. The discal patch (43:16) consists of a long, moderately slender, slightly arcuate stripe, extending from the last divarication of the median to the middle of the basal two-thirds of the submedian nervure; it is about half as broad as the cell, and about nine times as long as broad; it is composed of small, closely compacted, suberect, iridescent, blackish scales, increasing in size toward the base, and along nearly the whole extent of its lower border exhibits a slender cleft in which are silvery, cinereous or buff scales; it is accompanied along nearly or quite the whole of its inferior border by a slender, rounded cloud of dusky, suberect scales, mingled with tawny ones; the cloud varies in width, but is usually about as broad as the patch. In the ♀, on the basal half of the wing, the extremity of the cell is occupied by a squarish spot, similar in general appearance and color to the outer spots, and the whole base of the wing, especially along the costal margin to its middle, along the inner margin to the outer limits of the medio-submedian spot and on either side of the subcostal and median nervules halfway to the tip of the cell, rather heavily powdered with tawny. Outer margin delicately edged with blackish. Fringe pale on the lower half of the wing, tinged with yellow; on the upper half pale cinereous, becoming gradually more infuscated toward its base; it is usually dusklar in the ♀ than in the ♂. *Hind wings* crossed in the middle of the outer two-thirds or three-fifths by a moderately broad, curving, pale tawny band—paler in ♀ than in ♂—composed of nearly equal quadrate spots, slightly longer than broad, separated only by the dark nervules; it extends from the upper subcostal to the middle of the medio-submedian interspace, and the spot in the interspace beyond the cell is removed slightly beyond the others, noticeable mostly in following the interior limits of the band; there is also a small round spot of similar color, sometimes obsolete, at the bottom of the cell just opposite the origin of the first branch of the median nervure, and the whole lower half of the wing, excepting near the margin is covered with tawny hairs. In the ♂ the tawny spot and band are usually connected so as to form a large discal patch, more or less infuscated along the sides of the nervures in the basal half of the wing and, on all sides, having its limits vaguely defined and outwardly often approaching the border along the nervules; yet at other times the markings altogether resemble those of the ♀. Fringe like the lower half of that of the fore wings.

Beneath cinnamonaceous, sometimes with a fulvous tinge, the markings on the upper surface of the ♀ repeated beneath in both sexes, as whitish or pale yellow spots, more commonly the former on the hind wings; on the *fore wings*, the spots in the lower median and medio-submedian interspaces are usually combined into a large, common,

triangular patch, resting on the submedian nervure. Its sides nearly equal, especially in the ♂, where it is largest, bordered without by blackish clouds, and within by a blackish field which occupies the whole of the lower half of the base of the wing in the ♀, but is intensified on or confined to the neighborhood of the median nervure in the ♂; fringe blackish fuscous toward the base, but otherwise agreeing with that of the upper surface. *Hind wings* with the discal spot nearly always present, and the band in outer half of the wing differing somewhat from that on the upper surface; the spots vary in color from silvery white to straw yellow, and are usually more independent than above; they form a bent series, a little narrower and longer than above, with nearly equal limbs, the upper straight, the lower at a right angle or slightly more than a right angle to it, and slightly arcuate, the concavity outward; the spot beyond the cell forms the angle of the series, and is situated a little beyond the middle of the interspace; there are two spots above it, usually more separated than those of the lower limb, the costo-subcostal interspace being furnished with one; so also, at the other extremity of the band, the spot in the upper half of the medio-submedian interspace is accompanied by a smaller, vague spot in the lower half of the interspace, slightly nearer the outer border. Basal half of the fringe blackish fuscous, beyond similar to the upper surface of the same.

Abdomen black, almost entirely concealed on the side, and to a considerable extent above, with tawny scales; base covered with dark olivaceous hairs; beneath covered with tawny scales, and toward the base with hairs like those on the thorax. Upper organ of the male appendages (57:26) with the centrum rather deeply sulcate above, the hook very large and broad, as long as the centrum, but a little longer than broad, pointed, and a little hooked at the tip; lateral arms together scarcely one-fourth as broad as the hook, extending just as far as it. Claspers two and one-half times longer than broad, not half so broad at tip as at base, the upper margin very broadly rounded, with a minute denticle at base, the broad, upturned, triangular, sharply pointed tooth of the apical lobe preceded by a slight denticle at the extremity of the upper margin, and interiorly by a row of four or five blunt denticles on the recurved edge of the lower margin.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 15 mm.						
Length of fore wing.....	16.5	17.	17.5	16.25	17.5	19.5
antennae.....	7.5	8.	8.5	7.4	7.8	8.5
hind tibiae and tarsi.....	8.5	9.4	9.75	8.25	9.5	10.
fore tibiae and tarsi.....	6.	6.5	6.5	5.75	6.2	6.65

Described from 16 ♂, 10 ♀.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wings; the scales contained in it consist of jointed threads, with the joints of unusually large size and distinctly fusiform (51:1e) situated in the heart of the stigma, and accompanied by awl-shaped rods (11) expanding at the extreme tip; at the extreme base of the stigma are found only rod-like scales, of nearly equal width at the tip, truncate (1h) or two-pronged (1a); at the extreme tip are found somewhat similar two-pronged scales, enlarging very gradually, but considerably, from the base to the apex, the apical prongs being lateral and slight, and separated by a broad, rounded tooth (1b); in the field below the stigma are found either large quadrate scales with the apical margin somewhat similar to those last mentioned (1g), or long and rather slender scales, enlarging more or less apically, with entire but subtruncate outer margin (1c, d); besides, there are other triangular scales, with convex margins and fine converging striae (1f).

Egg (66:33). Cells .0127 mm. in diameter. Surface profusely punctate in the most minute and delicate manner; the punctuations are shallow, circular, and .004 mm. in diameter. The micropyle (69:11) consists of a cluster of about half a dozen pores within a diameter of .0115 mm., surrounded by an annulus of elongated, pentagonal cells, without punctures, occupying a field .027 mm. in diameter; around them

the cells grow rapidly more and more punctuate, and when a radius of .0675 from the centre is reached, they become normal. Color of egg dead white, slightly tinged with green. Height, .96 mm.; width, 1.32 mm.

Caterpillar. *First stage* (73:10; 77:32). Head (80:66) shining dark reddish brown, posteriorly brownish fuscous, the lower edge of the triangle blackish fuscous; surface distantly and slightly punctuate and very weakly vermiculate, with a few short, scattered, delicate, pale hairs; ocelli yellowish brown in a blackish field; third joint of antennae blackish fuscous. Body white, with a slight yellowish tinge, anteriorly dull purplish by the color of the internal organs; dermal appendages blackish fuscous; dorsal thoracic shield dark reddish brown, piceous at the edges; first pair of thoracic legs blackish fuscous, the others very pale testaceous, slightly infuscated at tip; prolegs the color of the body; stigmata blackish. Length of body, 3.8 mm.; breadth of head, .75 mm.; of body, .62 mm.; dermal appendages .06 mm. long, .02 mm. broad at the apex; longest bristles on the terminal segment, .32 mm. long.

Second stage (77:33). Head (80:67) black. Body pale green, the dorsal thoracic shield fuscous, with black margins; in front of the segment, pinkish brown. Body flocked with minute blackish papillae, supporting very short hairs; last segment of the abdomen with longer hairs, half as long as the segment but not recurved. Described from drawings lent by Mr. Edwards.

Distribution (31:2). This butterfly is a characteristic member of the Alleghanian fauna, but extends also south, and perhaps to some extent north, of its limit. In the Carolinian fauna it does not seem to have been taken south of the Virginias, excepting in northeastern Florida (Scudder) and at Indian River (Edwards). Mr. Billings credits it to Ottawa, and Mr. Fletcher says it is very ^{rare} ~~common~~ there, but the only other places in Canada where it has been found are London, Ont., "very rare" (Saunders), Montreal, one specimen (Caulfield) and Chateauguay Basin (Pearson).^{*} In the Alleghanian fauna it occurs from the Atlantic to Iowa (Allen, Putnam) and eastern Kansas, rare (Snow).

In New England it is mostly confined to the southern half, having rarely been taken north of 43° 30' N. L., the northernmost localities being southern Vermont (Scudder), Dublin (Faxon), Milford (Whitney), and the White Mountains, N. H., rare (Sprague); Hallowell, very rare (Miss Wadsworth), and Portland, Me., common (Lyman); Andover (Sanborn), and Pelham Hills, Mass. (Parker); on Cape Cod and along the southern shore as well as on Nantucket, it can always be found in considerable, sometimes extreme, abundance, but varies elsewhere according to the year.

Haunts. The butterfly frequents the open country, and is exceedingly fond of flowers, and is always easiest captured on them; it especially delights in asters, golden rod and thistles.

Oviposition. All the eggs I have seen were laid in confinement, the first ones in boxes sent me by Messrs. Whitney and Hamby; most of them were unattached; of those which were attached some were placed on

^{*} In this instance, however, the identification of the species is almost certainly wrong, If Pearson's specimens were taken, as he says, June 30 and July 1.

the bottom, some on the sides of the box; latterly I have obtained very many from confined females on grass, where, also, the attachment was so light that the blades had to be cut with scissors to prevent their falling to the ground when the grass was plucked. They hatch in from fifteen to twenty days and are often twelve hours in eating their way out of the shell.

Food and habits of the caterpillar. The caterpillar feeds readily on common grasses, but when hatched does not construct a nest at once, but wanders about upon the blades. Apparently they winter before moulting in New England, as I have never been able to carry one beyond this stage: specimens placed in a refrigerating house were dead in the spring.

Life history. Perhaps its variation in abundance is due to the fact that it is single brooded and hibernates in the caterpillar state while still quite young. How early in the spring it begins again to feed and how long it remains in the summer time in the chrysalis is unknown, but the caterpillars are unquestionably slow feeders, since the butterfly does not appear until the latter part of August, generally between the 20th and the 23d, occasionally as early as the 17th; the female usually appears nearly a week later, and individuals continue to emerge from chrysalis until the end of the first week of September; it has usually disappeared before the end of September. Eggs are laid at least during the first three weeks of September and are hatched in fifteen to twenty days. Of course the caterpillars must soon seek winter quarters. In Florida worn individuals—even males—may be found in March or April; perhaps these have hibernated, but it may well be that the seasons are different there, or the species double brooded.

Desiderata. It is particularly desirable that the history and habits of this insect should be traced after it has left the egg; special inquiry should be directed toward the nature of its winter quarters and the duration of the chrysalis stage. How do its seasons differ in the south? The parasites of the insect, the natural food plant of the larva, and the characteristics of the flight and postures of the butterfly should also be studied.

LIST OF ILLUSTRATIONS.—ANTHOMASTER LEONARDUS.

- | <i>General.</i> | <i>Imago.</i> |
|---|--|
| Pl. 31, fig. 2. Distribution in North America. | Pl. 10, fig. 12. Female, upper surface. |
| <i>Egg.</i> | 14. Male, both surfaces. |
| Pl. 66, fig. 33. Outline. | 13: 11. Male, both surfaces, in black. |
| 69: 11. Micropyle. | 37: 26. Male abdominal appendages. |
| <i>Caterpillar.</i> | 42: 15. Neuration. |
| Pl. 73, fig. 10. Caterpillar at birth; plain. | 43: 16. Discal stigma of fore wing of male. |
| 77: 32, 33. Caterpillar in stages I, II; colored. | 51: 1. Scales of the discal stigma. |
| 80: 60-67. Front views of head, stages I, II. | 59: 7. Side view of head and appendages enlarged, with details of leg structure. |

POLITES SCUDDER.

Polites* Scudd., Syst. rev. Amer. butt., 57 Hesperia pars Auctorum.
(1872). Pamphila pars Auctorum.

Typa.—*Hesperia peckius* Kirby.

With the rose the butterfly's deep in love,
A thousand times hovering round;
But round himself, all tender like gold,
The sun's sweet ray is hovering found.

With whom is the rose herself in love?
An answer I'd fain receive.
Is it the singing nightingale?
Is it the silent star of eve?

I know not with whom the rose is in love,
But every one love I:
The rose, the nightingale, sun's sweet ray,
The star of eve and butterfly.

HEINE (*Transl.*).

Imago (59:5). Head pretty large, heavily clothed above with moderately long hairs, mostly arranged in a transverse mass, in the middle of which the antennae lie; just outside of the antennae a slightly spreading, compressed, lateral tuft of arcuate bristles, passing about one-fourth way over the eye. Front very protuberant, wholly and considerably advanced beyond the front of the eyes, almost regularly tumid, slightly flattened in the middle third, sulcated slightly, longitudinally and a little obliquely a little outside of the middle of either half, attaining neither border, but, just before reaching the front border, bent strongly toward the middle of the same; posterior border minutely bituberculate in the middle; the whole piece nearly two and a half times broader than long, the front border straight in the middle third, obliquely sloped off on the lateral third to a point opposite the centre of the front and in front of the outer edge of the antennae, to which it is then bent; separated from the vertex by a nearly straight, slightly impressed line connecting the middle of the antennae and forming the bottom of a very broad, shallow sulcation. Vertex rather tumid, regularly and considerably arcuate longitudinally, slightly and mostly toward the sides transversely, wholly surpassing the level of the eyes, separated from the occiput, which is deeply sulcate longitudinally in the middle, by a pretty strongly bent, somewhat impressed line. Eyes large, full, nearly circular, scarcely truncate behind, naked. Antennae inserted in the middle of the summit in rather distinct depressions, separated from each other by nearly four times the diameter of their basal joints, the whole antenna scarcely shorter than the abdomen, composed of thirty-three to thirty-five joints, of which eighteen or nineteen form the club, which is about half as long as the stalk, stout, oval, a little compressed, increasing very gradually at the extreme base, afterwards more rapidly and at the extremity (excluding the crook) very broadly rounded; the crook consists of from four to six joints, one more in the ♀ than in the ♂, forming a tapering appendage, slenderer in the ♀ than in the ♂, from one and one-fourth to two times as long as its basal breadth and from one-third to one-half as broad as the club proper; the latter is from three to four times as long as broad, largest at about the middle of its apical half or from the tenth to the twelfth joint from the tip of the antennae; middle joints of the stalk about three times as long as broad, the third from base of the antennae scarcely longer. Palpi moderately long, about twice the diameter of the eye, stout, clothed very compactly with a heavy mass of not very long scales, beyond which the terminal joint, clothed with recumbent scales, projects but a little distance; basal joint bullate, subpyriform, rather longer than broad, with a tumid, forward projection at the inner extremity; middle joint bullate, obovate, equally and broadly rounded at either extremity, but slightly arcuate, of the breadth

* πολίτης, a citizen, in allusion to one of the names formerly given to the group, Urbicolae.

of the basal joint, two and a half times longer than broad, equalling the diameter of the eye; terminal joint placed at the middle of the summit of the middle joint, slender, straight, cylindrical, bluntly rounded at either extremity, from five to six times as long as broad, and as long as the breadth of the middle joint.

Prothoracic lobes rather small, subtriangular, the inner and lower edges nearly straight and equal, the upper outer side being pretty regularly arcuate, as long as the shorter diameter of the eye, fully half as long again as high. Patagia of moderate size, somewhat shorter than the breadth of the head, the posterior lobe scarcely more than one-third as broad as the base, half as long again as it, equal, straight, slightly narrowed at the rounded tip.

Fore wing (42: 13) much less than twice as long as broad, the lower outer angle falling well outside the middle of the costal margin; costal margin distinctly though very slightly concave, at least in the male; outer margin rather gently and regularly rounded. The costal nervure terminating scarcely beyond the middle of the costal margin; subcostal nervure moderately approximate to the costal margin, the second nervure arising in the middle of the wing; median nervules arising as in *Atalopodes*; internal nervure short, straight, with an obscure connection with the submedian nervure.

Hind wing a fifth longer than broad, the basal lobe very large; costal margin straight to the tip of the costal nervure; outer margin well rounded, fullest in the medio-submedian interspace, the anal angle rectangular, well rounded. Subcostal nervure forking shortly before the median, the median at no great distance before the second forking, which is itself before the centre of the wing.

Discal stigma of male consisting of an interrupted, gently arcuate or sinuate streak of dead black retrorse scales or rods edged below, especially in the middle, with a border of similar, but dust-colored erect rods and followed beneath by an inconspicuous, large area of loosely compacted, erect, dusky scales. The scales of the stigma consist, in the heart, of jointed threads only, while at the base are found a considerable variety of spatulate and two-pronged rods and scales and triangular, apically truncate scales, which are replaced in the field below the stigma by slender, triangular scales with a roundly produced apex.

Legs 2, 3, 1. Femora and tibiae clothed as in *Anthomaster*, but with inconspicuous tibial spines on the upper surface. Femora 2, 1, 8; tibiae 2, 3, 1; tarsi 2, 3, 1. Fore and hind femora more than two-thirds as long as the middle femora. Fore tibiae two-thirds the length of the fore femora, fully half the length of the middle and hind tibiae. Leaf-like appendage of fore tibiae long and slender, lanceolate, attached at the middle of the outer four-fifths of the joint and surpassing its extremity, fully five times as long as broad, tapering, pointed, and a little curved; other tibiae armed at the tip with a pair of very long and very slender, more or less unequal spurs, the hind tibiae with a similar pair in the middle of the outer two-thirds; both tibiae have three or four very long spines ranged in a row on the under edge of the outer side. Tarsal joints 1, 2, 3, 4, 5; fore tarsi nearly four-fifths as long as the middle and hind tarsi, a little longer than the middle femora, all furnished with a triple row of pretty long, delicate spines, the apical ones of each joint a little longer than the others; basal joint nearly as long as all the rest together; second nearly or quite half as long as the basal. Claws pretty small, compressed, tapering, strongly and regularly arcuate. Pad not very large, transverse. Paronychia bilobed; the upper lobe laminate, compressed, of the size and shape of the claw but less arcuate and not so pointed; the lower slender and equal, a little more than half as long as the other.

Abdominal appendages: Upper organ somewhat resembling that of *Hylephila* being slender, depressed, well arched, and thrust far backward. Hooks connate, tapering a little, blunt at tip, slightly upcurved; lateral arms nearly obsolete, closely appressed to sides of hook. Clasps broad, sacre-shaped, not so long as the upper organ, equal nearly to the tip, the extremity of the upper margin incurved, making the upper posterior angle abrupt.

Egg. Pretty high, broadest at the base, rounded, but very little narrowed on the basal half, above well rounded, the summit not flattened; surface broken up by exceedingly slight, raised lines into quite regular, equiangular, hexagonal cells.

Caterpillar at birth. Head moderately large, broadest opposite the upper limit of the ocellar field, elevated, narrowed and domed above; the triangle nearly half as high again as broad, reaching considerably above the middle of the front, the middle opposite the middle of the ocellar field, occupied by a pair of papillae, equidistant from each other and the sutures, bearing long and slender bristles; similar paired papillae, bearing long and slender, scarcely arcuate bristles, are found outside the triangle just above its upper limit and next the middle of its upper half, besides lateral ones in the centre of the ocellar field, just above the middle, and at a similar distance and as far above this as the ocellar bristle is below it; ocelli unequal, prominent but flat; third joint of antennae nearly half as long again as broad, cylindrical but slightly enlarged apically and arcuate on the inner side; the joints of the maxillary palpi successively half as broad as the preceding, the basal quadrate, all of nearly equal length. Body slender, cylindrical; dorsal thoracic shield as broad as the spiracle of the same segment, furnished with pretty long, tapering, pointed, distant hairs; the bristles of the body long, slender, distinctly tapering and minutely but distinctly enlarged at the tip into a comparatively long club, not so broad as the base of the bristle; they are considerably longer than the segments and arranged as follows: a laterodorsal series, slightly nearer together on the thoracic than on the abdominal segments, placed anteriorly; a lateral series placed posteriorly; a suprastigmatal series placed mesially; a stigmatal series placed anteriorly; and an infrastigmatal series placed posteriorly; the stigmatal bristles are shorter than the others and the laterodorsal series are transformed on the last abdominal segment into longer, somewhat recurved, tapering hairs.

This North American genus comprises but three species, two western, the third eastern, inhabiting a zone extending from Atlantic to Pacific, between the 35th and 56th degrees of latitude. The eastern species is abundant throughout New England.

They are butterflies of very small size, the male possessing an arcuate discal streak on the fore wings. The wings are dark brown above, marked with tawny, especially in an extra-mesial transverse band of spots and along the costal margin of the fore wings. Beneath they are ferruginous and the middle of the hind wings have conspicuous, very large and irregular yellow spots.

The metamorphoses of one species are partially known. The butterflies are single or double brooded; how they pass the winter is uncertain, but probably either as chrysalids or as mature caterpillars. The butterflies frequent meadows and highways and have a very lively flight. In repose their wings are raised at different angles.

The eggs are unusually high and regularly domed, greenish white and very profusely punctate. The caterpillar at birth has a nearly white body with black head and thoracic shield, and the dermal appendages scarcely expanded at the tip and longer than usual, being as long as the segments. Afterwards the caterpillar becomes of a griseous color from the multitude of dark papillae on the pale brown ground color. The caterpillars feed on grasses.

EXCURSUS LXX.—SEXUAL DIVERSITY IN THE FORM OF THE SCALES.

And pluck the wings from painted butterflies,
To fan the moonbeams from his sleeping eyes.
SHAKESPEARE.—*Midsummer-Night's Dream*.

SCALES are a characteristic adornment of Lepidoptera. It is altogether through them that the gorgeous or exquisite colors, delicate or striking patterns are found upon the wings of butterflies. The colors or the patterns may differ in the two sexes, as has been before remarked; but these variations may or may not be accompanied by a difference in the form or structure of the scales composing the pattern or producing the color. In general, however, the scales over the surface of the wings are everywhere essentially alike. But in certain butterflies, and these form a considerable proportion—certainly in our own fauna more than half the species, the males possess, in addition to those forming the common plumage of both sexes, certain scales of an altogether distinct and unique kind.

These peculiar scales, or androconia as they have been termed, in reference to their masculine nature, were first noticed by Bernard-Deschamps more than fifty years ago, but have never been properly studied throughout the butterflies. Deschamps called them plumules from their feathery tips; but this term is utterly inappropriate to most of them; and their form is so varied that only some word expressing their masculine character should be accepted, since this is their single common peculiarity.

These androconia are very capricious in their occurrence; a number of allied genera may possess them, while a single genus, as closely allied, may be quite destitute. This is true throughout the butterflies; and yet there are large groups in which they are altogether wanting, and others in which their absence is extremely rare. In the Satyrids and in some other of the higher butterflies they are long, slender, and invariably feathered at the tip; in one small group, the Heliconinae, they are toothed as well as feathered, though with this exception they may be distinguished from ordinary scales by the absence of any dentation at the tip. In the Pieridi they are fringed, and with a single known exception their extreme base is expanded into a sort of bulb; elsewhere, even in the other groups of the subfamily to which the whites belong, they are not fringed, but have a smooth rounded edge. In the Lycaenidi they assume a battledore or fan-shape, with a smooth edge, and are generally beaded and more heavily striate than the scales. The same is true, but with more variations, in the other Lycaeninae. In the swallow-tails, where they have been supposed to be wanting, they differ less from the ordinary scales, but are much smaller and more coarsely striate. In the skippers they present the greatest

variety in the same individual ; in one group there are hair-like androconia, sometimes jointed ; in another group, besides hair-like androconia, there are usually some which are spoon-shaped with long handles, or of other odd forms.

As a general rule these androconia are present in the patches to which we have before alluded as forming one phase of the antigenic characters of the male ; but more often, as in the blues and whites, they are scattered indiscriminately, or in rows, over the upper surface of the wings ; they sometimes occur in patches on the hind wings, as in the fold next the inner margin of the swallow-tails ; but, with the exception of the discal spot of the hair-streaks, they seem to be present in all patches found on the front wings, occasionally forming the principal part of such patches, as in many yellows, and again taking no part in the display. Take, for example, the fritillaries, where so many small black scales are crowded against certain veins as to give them a thickened appearance ; the androconia are also present in great numbers, but entirely concealed ; only by removing the scales can even the tassels of their long and slender blades be seen. Perhaps even more curious than this is the arrangement by which all the androconia of the swallow-tails and of the Hesperidi are tightly inclosed in the fold of the costal membrane to which reference was made in a recent excursus. Indeed, with rare exceptions, such as in the patches on the fore wings of the Theclidi, every provision seems to have been made for their concealment. In the Pamphilidi for instance, though the patch which contains them is conspicuous enough, it is so mainly because of the great imbricated scales which are massed so as to conceal the androconia proper. In other instances where they are not massed into patches, they are individually smaller than the other scales and concealed by them, so that there concealment may be looked upon as definitely related to their use.

The nature of this use was first detected by Fritz Müller, who gave them the name of *duftschuppen*, or scent scales, as has already been stated in the excursus on Aromatic Butterflies. There can certainly be no doubt that this is their office in some instances, and all analogy would lead us to believe it true of all, although we have not such power of scent as to be able to prove it.

But when this is granted there is much more to be said. They differ marvellously from ordinary scales in the variety of their form and exquisite structure, and we have still to inquire the meaning of this. Ordinary scales almost seem made on a single pattern ; they are small enough, but they are huge as compared with most androconia ; why such delicate and exquisite patterns on such a microscopic scale ? Who is to see and benefit by them ? Assuredly not the insects themselves ; they may profit, indeed, by their function, and no doubt natural selection has perfected that to the uttermost, even beyond our ken ; but we have seen that such objects are

practically invisible to them. Is there not here a beauty of form and of structure which is an end in itself, subserving no material end, of no possible profit to the possessor?

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 See also the papers cited on page 1640, and numerous others by Fritz Müller on the odoriferous organs of butterflies.

POLITES PECKIUS.—The yellow spot.

[Yellow spot (Gosse); yellow spotted skipper (Gosse); Peck's skipper (Harris).]

- Hesperia peckius* Kirlb., Faun. bor-amer., iv: 300, pl. 4, figs. 2, 3 (1837);—Harr., Ins. inj. veg., 3d ed., 315-316, fig. 139 (1862).
Pamphila peckius Kirlb., Syn. ent. Lep., 600 (1871);—French, Rep. Ins. Ill., vii: 160 (1878); Butt. east. U. S., 317-318, fig. 84 (1886);—Fern., Butt. Me., 90-100 (1884);—Mayn., Butt. N. Engl., 61, pl. 8, figs. 90, 90a (1886).
Polites peckius Scudd., Syst. rev. Am. butt., 57 (1872).
Pamphila peckii Morr., Syn. Lep. N. Amer., 120 (1862).
Hesperia weansutta Harr., Ins. inj. veg., 3d ed., 318, fig. 141 (1862);—Morr. Syn. Lep., N. Amer., 111-112 (1862);—Saund., Can. ent., i: 65-67 (1869);—Pack., Guide Ins., 270, fig. 198 (1869).
Pamphila enys Boisd., Butl., Entom. monthl. mag., vii: 93 (1870).
 Figured also by Glover, Ill. N. A. Lep., pl. 63, fig. 9; pl. G, fig. 14; pl. K, fig. 12, incl.
 Der Frühling kommt in's Land herein,
 Er fliegt auf Schwaben-schwingen,
 Und vor ihm her und hinterdrein
 Die Vögel alle singen,
 Und schweigend wohl, doch froh genug,
 Umflattert ihn mit leisem Flug
 Und Zug auf Zug
 Ein Heer von Schmetterlingen.
 WACKERNAGEL.—Frühlingslied.
 I follow'd fast, but faster he did fly.
 SHAKESPEARE.—Midsummer-Night's Dream.

Imago (10: 18, 22; 13: 12, 14). Head covered above with mingled greenish tawny and blackish hairs, the former becoming yellowish toward the sides; the tufts on either side of the base of the antennae are composed of mingled pale tawny and black bristles, the latter predominating behind, the former in front; beneath the eye the scales are very pale buff, growing deeper in color behind the eye and tinged with orange above. Palpi very pale, rather dingy, buff, with a slight greenish hue, tinged slightly with tawny toward the tip, the apical half flecked with infrequent black hairs.

projecting a little beyond the others. Antennae blackish above, having greenish and purplish reflections on the club; beneath nacreous, on the inside, where it is tinged with orange, interrupted with black at the tips of the joints; the apical half of the under surface of the club and the crook is naked and dull orange, the last joint of crook dusky, edged with a narrow border of black scales, which on the inside is followed by a bright orange, on the outside by a nacreous patch, the former usually wanting in the ♀; whole upper surface of crook black. Tongue black, the tip dark mahogany brown.

Thorax covered above with dusky and olivaceo-tawny hairs, tinged more deeply with tawny toward the sides; beneath covered with very pale greenish buff hairs, tinged with tawny toward the base of the wings. Legs tawny buff, marked above considerably with dark brown, beneath more or less dull silvery; spurs dull silvery, brownish on the side away from the leg, dark reddish at the extreme tip; spines dusky luteous; claws rather dark reddish; pad dusky.

Wings dark brown, with very slight, very dark green reflections, marked with bright tawny. *Fore wings* having the costal margin heavily and broadly marked with tawny; in the ♂ it always extends from the discal stigma to the costal edge, persistent directly above the stigma, and usually extending to the base of the wing on one side, and nearly or quite to the extra-mesial row of spots on the other; in the ♀ it is never so largely developed, and is usually greatly obscured by dark brown; at the most it occupies the outer half of the cell (with a dusky dash along the centre of the same) and the interspaces above it, the dusky nervules diminishing its importance; but it is not infrequently reduced to a small spot at the extremity of the cell, or a flush of tawny above the outer half of the same. In the middle of the outer half of the wing is a transverse series of tawny spots, consisting, first, of three longitudinal spots forming a single transverse spot, divided by dusky nervules, depending from and at a right angle, or a little less than a right angle, to the middle of the outer half or two-fifths of the costal margin; second, of two minute, occasionally obsolete, squarish spots, half the distance of the former from the outer margin, the upper generally the outer, situated in the interspaces beyond the cell; and third, of one, two or three large spots in the median and medio-submedian interspaces, the uppermost, always present, occupying the base of the upper median interspace, the others confined to the ♀, where the lower is frequently absent or obsolescent, that in the lower median interspace squarish, larger and removed a little within the one above it, the lowest of very variable shape, often double, and when fully developed, as it is more frequently southward, largest below. Not infrequently the base of the wings is delicately powdered with tawny scales in the ♀, and especially along the inner border; but in the ♂ this is always the case, and to such an extent as often to form on the lower part and base of the wing a tawny field as deep as that on the costal border and continuous with it, thus enveloping the inner part of the discal stigma. The latter (43:18) is a moderately broad, equal and gently though not regularly sinuate stripe, eight times as long as broad, extending from the last divarication of the median to the middle of the basal two-thirds of the submedian nervure; the principal situation is where the lowest median nervule crosses it, where also its otherwise uniformly black, compact, velvety, hairy mass is infringed upon and occasionally divided by loosely compacted, bright tawny scales below the nervule, and by similar dark brown ones above; either extremity is rounded, and along the whole of its inferior edge, excepting next the outer extremity, it has a slender, chitinous, naked edge, which again is followed outwardly by an inconspicuous, broad, roundish area, composed of slightly erected, slate brown scales; the area extends two-fifths of the distance to the outer margin, and is equally situated on either side of the lowest median nervule. Fringe pale, mingled, especially on lower half, with pale tawny scales, the base overlaid by blackish fuscous. *Hind wings* with a broad, transverse, curving belt of tawny, of irregular width, in the middle of the outer two-thirds of the wing, broken distinctly by the brown nervules, and thus composed of longitudinal bars of varying lengths, and when most fully developed, extending from the costal nervure to the middle of the medio-submedian inter-

space; the spot in the costo-subcostal interspace is seldom present, and when it occurs is very small, its outer limit on a line with the interior limit of the spot below, which occupies the middle third of the subcostal interspace; that in the interspace beyond the cell is longest, being usually twice as long as broad, divided longitudinally in the middle by a dusky line, and distant from the tip of the cell and the border of the wing by about the width of the interspace; the one below occupies the basal two-fifths of the upper median interspace, while that in the lower median interspace extends further toward the base and to a similar point outwardly; the spot in the upper half of the medio-submedian interspace is seldom present, and then often obscure, always small, just below the one above it; occasionally, also, there is a small, tawny spot in the lower half of the cell, just above the base of the lowest median nervule. Fringe as on the fore wings.

Beneath: *Fore wings* dark fuliginous brown, the upper half and the outer margin much glossed with tawny, often giving it a cinnamonaceous tint; the markings of the upper surface of the female repeated beneath in yellow in both sexes; outer margin with a slender blackish edge, the fringe much as above. *Hind wings* mostly occupied by two large, broad, sharply defined bands of deep straw yellow, often confluent in the middle of the wing; otherwise the wing is ferruginous or cinnamonaceous, enlivened with flushes of fulvous or tawny in small interspaceal spots seated on the outer border; the inner of the two yellow bands runs parallel to the inner border, its interior margin nearly touching the base, its upper limit at an equal distance from the costal margin, or midway between the costal nervure and the costal margin; its exterior margin parallel to its interior, but usually irregular or crenate, directed toward and usually reaching the second divarication of the median nervure; here it is usually connected more or less closely with the outer band; not infrequently the basal band is confluent with the other throughout the whole lower half of the exterior margin of the former, and sometimes it touches it only at its lower extremity and in the middle of its exterior margin; the outer band is transverse, arcuate, subparallel to the outer border, very broad and reaches from the costal to the submedian nervure; its breadth is unequal, tapering a little toward the inner border, and in the interspace beyond the cell abruptly broadened, often to twice, rarely even to thrice, the breadth of the adjoining parts, occupying the basal three-fourths of the interspace or even almost touching the outer margin; next the costal margin it terminates squarely against the nervure; below it is rounded; the upper half of its exterior border usually consists of a series of angular steps successively further from the base, while the lower half is continuous; in the lower median interspace the interior edge of the band almost always extends toward the base of the wing, occupying the whole base of the interspace and thus connecting with the basal band; usually the bands are unbroken, but occasionally the nervures which traverse them are dusky; the outer margin edged delicately with a blackish line; the fringe much as upon the upper surface.

Abdomen blackish brown above, enlivened with tawny hairs, especially on the lower half of the sides, the apical half of the joints and the apical half of the abdomen. Beneath pale yellowish brown, with a greenish tinge. Male appendages (37:24, 25) with the centrum of the upper organ composed almost wholly of the lateral walls; hook scarcely arched and just before the tip slightly upcurved, tapering only just beyond the middle, three or four times as long as broad. Clasps three times as long as broad, very simple; lower border a little convex, the upper a little concave, the upper posterior angle a little less than a right angle, the extremity of the upper margin incurved to form a minute, horizontal, spatulate, lobe-like expansion.

Measurements in millimetres. Length of tongue, 13 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	11.	13.	13.75	11.75	14.	15.
antennae.....	5.5	6.1	6.5	5.5	6.25	6.8
hind tibiae and tarsi..	5.75	7.1	7.25	6.2	7.25	7.6
fore tibiae and tarsi..	3.75	4.65	4.85	4.15	4.75	5.

Described from 131♂, 71♀.



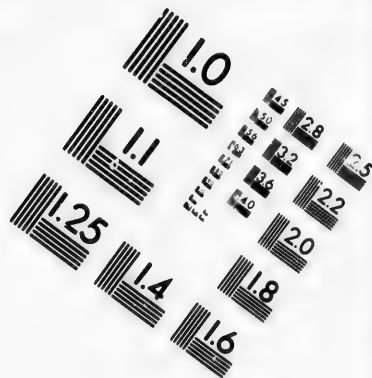
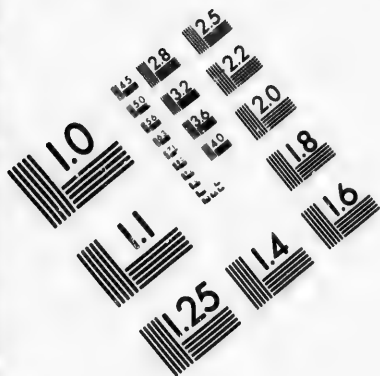
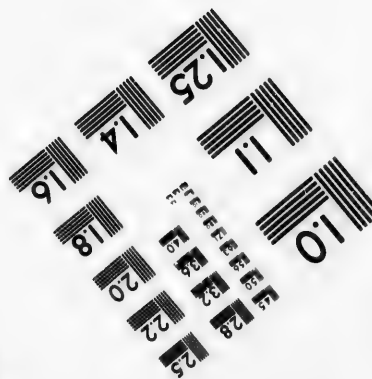
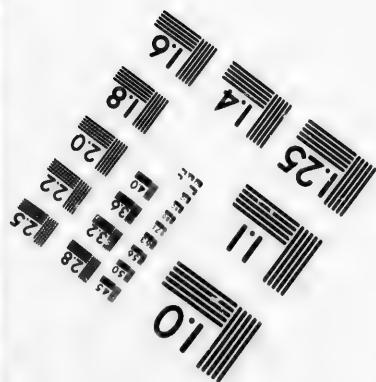
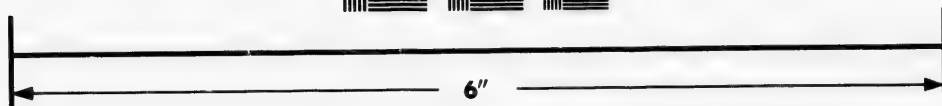
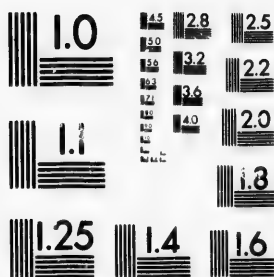


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Accessory sexual peculiarities. The discal stigma of the male has been described under the wings; the scales contained in it are very slender jointed threads, consisting of seven or eight equal joints (50:2 d, f); at the extreme base of the stigma are found some faintly spatulate scales (2 h), very long and slender, enlarged slightly next the base as well as next the tip, and of other very long and slender nearly equal scales (2 a); next these, but still at the base, are found two-pronged rods or scales of two different types, one rod-like and exceedingly slender (2 g), the other scale-like with very prominent triangular prongs (2 b), together with some triangular striate scales abruptly truncate at the apex (2 c); the field below the stigma is filled with a mass of oblanceolate scales (2 e), well rounded and produced at the apex, regularly tapering from a slender base to the moderately broad tip, finely striate, having the appearance of being broken by fine cross lines, yet giving in certain lights the effect of converging striae.

Egg (66:28). Cells .03 mm. in diameter; surface glistening greatly, covered with punctuations, fifty or sixty to a cell, nearly circular, and not more than .0015 mm. in diameter, irregularly distributed. Color at first very pale green, nearly white; afterwards it becomes profusely mottled on one side, rather sparsely on the opposite, with thread-like dendritic markings of a bright red color. Height, .58 mm; diameter, .76 mm.

Caterpillar. *First stage.* Head (80:57) black, minute and scabrous, furnished with a few pale, tapering hairs, .08 mm. long; mouth parts blackish. Body white, furnished with long, pale fuscous bristles, .16 mm. long and of equal size throughout; they are slightly curved and seated on fuscous papillae; the stigmatal bristles are shorter than the others; the subdorsal bristles terminate on the last segment with a long, somewhat recurved hair, .38 mm. long; spiracles blackish fuscous; dorsal thoracic shield black; thoracic legs pellucid white and very long, .22 mm. long; the joints, excepting the basal, slightly fuscous at tip, the terminal joint fuscous externally; the first pair more or less fuscous throughout; prolegs white. Length, 1.54 mm.; breadth of body, .32 mm.; of head, .46 mm. After eating, the general color becomes of a dusky grimy green and the papillae dark reddish brown.

Third stage. Head shining, piceous, delicately rugulose and covered with delicate, short, brownish hairs. Body rather pale brown, so thickly besprinkled with inky black, minute spots and papillae bearing short, delicate, blackish fuscous bristles, as to give the whole a blackish griseous color; a narrow, blackish fuscous, dorsal line; dorsal thoracic shield broad, equal, black; legs piceous; prolegs concolorous with the body. Length, 5.75 mm.; breadth, .75 mm.

Distribution (31:3). This butterfly appears to be found throughout nearly the whole extent of the Alleghanian and Canadian faunas. The southernmost localities from which it is known are West Virginia (Edwards), Cincinnati, Ohio, common (Dury), Kentucky (Brit. Mus.) and eastern Kansas, rare (Snow). The latter locality marks also its western extension in the south, and Ames (Osborn) and Davenport, Iowa (Putnam) are as far west as it has been reported in that section of the country. In Wisconsin it is considered by Hoy the most abundant of the skippers. To the north it is found throughout all the settled parts of Canada and has even been reported from Cumberland House on the Saskatchewan (Kirby), and Moose at the southern point of Hudson Bay (Weir); at Ottawa it is very common; it occurs to the eastward at Montreal, not common (Caulfield), Quebec (Bowles), Nova Scotia (Jones) and Cape Breton (Thaxter).

In New England it is everywhere the commonest of the Pamphilidi and

is found throughout every portion of the district from the White Mountains to the sea-coast.

Oviposition. All the eggs I have seen were laid by females imprisoned over grass and were laid loosely, quite unattached. Besides those so obtained myself, others have been sent me in similar condition by Mr. P. S. Sprague, Dr. Minot and Professor Hamlin. Those laid in June hatched in from eleven to twelve, possibly thirteen days, those in August in from twelve to fifteen days. Eggs laid for Mr. Saunders at London, Ont., in July, hatched in fourteen days.

Food and habits of caterpillar. Although Mr. Saunders and I have both fed this caterpillar for a short time on ordinary grass, we have both failed to rear it and this fact and its uneasy habits makes me inclined to think we need to know better its exact food. In one instance a caterpillar, after leaving the egg, remained motionless for several days on a blade of grass without eating and then disappeared. It leads a gypsy life; it wanders incessantly from its youth up and is uneasy at the least confinement; it makes a nest soon after its escape from the egg, but passes little of its time within it and soon abandons it for another. Its earliest nests are loosely constructed in a single blade of grass by uniting opposite edges with two or three threads; subsequently they are made of very few and slender threads stretched from leaf to leaf; all its nests are very delicate. It feeds both by day and night and is alarmed at the least motion, starting suddenly back into its nest with a movement quite unlike that of any other species of Pamphilidi, and not venturing forth again for some time. When it moves about, its head trembles from side to side as if it were afflicted with palsy.

Life history. It is double brooded in the southern parts of its range and single brooded in the northern portions; the change in New England will probably be found near the dividing line between the Canadian and Alleghanian faunas. Judging by the data at hand, Williamstown, Mass., will probably be found to belong in this respect to the southern half, though this is unexpected. Localities which certainly belong to the district where the butterfly is single brooded are Waterville, Me., the White Mountains, N. H., Compton, north of the Vermont border, and London, Ontario. Yet Mr Fletcher assures me that a second autumn brood is found at Ottawa. To the opposite category belong Andover, Boston and Springfield, Mass., Albany, N. Y. and points south of these places. In both, the winter is probably passed in the chrysalis state, though possibly in that of a mature caterpillar. In the northern area, where the insect is single brooded, the butterfly appears the last of June or early in July, occasionally by the middle of June in the southernmost districts; it continues upon the wing until after the middle of August, although by the beginning of the month

it has begun to diminish greatly. It is not until the butterflies have been at least two or three weeks upon the wing that the female commences to deposit her eggs, which are hatched in from twelve to fifteen days; the young larva is, therefore, seldom born before the end of July and sometimes not until the end of August. Its future history has not been traced. In the southern half of New England, where the species is double brooded, the earliest generation of butterflies appears upon the wing during the last week of May—at the beginning of the week, near the southern sea coast, toward its middle or end further north; both sexes become abundant in a week and continue on the wing up to the middle, sometimes to the end, of July, although often diminishing greatly in numbers during the latter half of June. The female deposits her eggs after the middle of June; these are hatched in eleven or twelve days, but at what time the caterpillars attain maturity has not been shown; the second brood of butterflies, however, appears early in August, sometimes by the very first day, but perhaps more frequently (except near the southern borders) by the 5th or 6th. In a few days it becomes abundant and individuals, continuing to emerge from the chrysalis for two or three weeks, remain upon the wing nearly or quite to the end of September. The history of their progeny has not been traced; facts seem about equally to favor the view that they hibernate as chrysalids or as nearly mature caterpillars; probably the insect will not be found to differ in this respect in the northern and southern half of New England.

Behavior of the butterfly. The butterfly is found everywhere in the open country, especially in meadows, by roadsides, along pathways and in all old forest openings; it is very fond of flowers—white clover, mint, golden rods, etc. When alighted on a flower to feed, all the wings are sometimes tightly closed, the costal edges together; or, both pair of wings are slightly and equally parted; at other times, the fore wings are placed at right angles to each other while the hind wings are horizontal; but when fairly at rest, as when it has alighted upon the horizontal surface of a leaf, the fore wings diverge at an angle of about 50° with each other, their inner edges resting upon the upper surface of the expanded hind wings which, instead of being quite horizontal, are deflected a little, so that the angle of divergence between the two wings of the same side is 80° or 85° . The antennae, viewed laterally, are straight and very slightly depressed, the tip of the club turned abruptly backward; viewed from above slightly curved, the convexities outward, and divergent at an angle of about 130° , the antennal tips being 11 mm. apart.

Desiderata. The distribution of this butterfly west of the longitude of Ohio, and especially in the northern parts of its natural district should be studied with care. In New England, the belt of country lying between the White Mountains on the north and the northern limits of Massachusetts

on the south, with the corresponding region to the west—especially about the northern limits of the Adirondacks—should receive the careful attention of observers, to learn, in each locality, whether the insect is single or double brooded. Quite as important is it to trace the complete history of the insect after the eclosion of the caterpillar, and particularly to determine in what condition and surroundings it passes the long winter. It would be interesting to know just how soon after the apparition of the females they begin to lay eggs, to collect the possible parasites which attack the insect and to note the peculiarities of the flight of the butterfly.

LIST OF ILLUSTRATIONS.—*POLITES PECKIUS*.

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| <p><i>General.</i>
Pl. 31, fig. 3. Distribution in North America.
<i>Egg.</i>
Pl. 66, fig. 28. Outline.
<i>Caterpillar.</i>
Pl. 80, fig. 57. Front view of head in stage i.
<i>Imago.</i>
Pl. 10, fig. 18. Male, both surfaces, colored.
22. Female, upper surface, colored.</p> | <p>Pl. 13, fig. 12. Male, both surfaces, in black.
14. Female, both surfaces, in black.
37: 24, 25. Male abdominal appendages.
42: 13. Neuration.
43: 18. Discal stigma of fore wing of male.
50: 2. Scales of the discal stigma.
59: 5. Side view of head and appendages enlarged, with details of the structure of the legs.</p> |
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THYMELICUS HÜBNER.

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| <p>Thymelicus Hübn., Verz. bek. schmett., 113 (1816);—Scudd., Proc. Am. acad. sc., x: 283 (1875).
Hedone Scudd., Syst. rev. amer. butt., 58 (1872).</p> | <p>Hesperia pars Auctorum.
Pamphila pars Auctorum.
Pyrrhosidia Scudd., Mem. Bost. soc. nat. hist., ii: 346, note (1874).
<i>Type.</i>—<i>Thymelicus vibex</i> Hübn.</p> |
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A high cliff-meadow lush with spring;
Gay butterflies upon the wing;
Beneath, beyond, unbounded, free,
The foam-flecked, blue, pervading sea.

LEWIS MORRIS.—*A Spring Picture.*

Imago (60: 1, 2). Head pretty large, heavily clothed with rather short hairs; just outside of the antennae a slightly spreading compressed tuft of arcuate hairs passing rather less than one-third way over the eye. Front protuberant, not very tumid, wholly but not greatly surpassing the front of the eyes, a little more prominent than elsewhere in a slightly elevated, broadly rounded, transverse ridge across the middle; the whole piece from two and one-half to two and three-fourths times broader than long, the front border margined and in the middle a little elevated, very broadly rounded, so that the piece appears nearly quadrate, roundly docked at the outer front angles; separated from the vertex by a slightly arcuate sulcation opening backward, varying in depth in the different species. Vertex a little tumid; its anterior two-thirds extending slightly beyond the summit of the eye, a little arched longitudinally, slightly bowed transversely at the sides but flattened, or even slightly depressed in the middle, separated from the occiput, which has a rather slight, longitudinal, central sulcation, by a distinctly impressed brace-shaped line, whose limbs incline but little. Eyes large, pretty full, nearly circular, naked. Antennae inserted in the middle of the summit, separated from each other by about two and one-half times the diameter of the basal joints, the whole antenna as long as (♀), or somewhat shorter than (♂), the abdomen, composed of from thirty-five to forty joints, of which from seventeen to twenty-one form the club, which is about half as long as the stalk, and, excluding

the crook, pretty stout, oval, scarcely compressed, increasing in size very gradually on the basal half and at the extremity much more rapidly, bluntly rounded; the crook consists usually of six, occasionally of more joints, forming a slender, regular, conical appendage, pointed at the tip, nearly three times as long as broad, and about one-third as broad as the club proper; this is from three to four times as long as broad, largest beyond the middle or at about the tenth to twelfth joint from the tip of the antennae; middle joint of the stalk from two and one-half to three times longer than broad, the third from the base of the antennae fully four times as long as broad. Palpi not long, scarcely more than one and one-half times the length of the diameter of the eye and pretty stout, heavily clothed with a mass of not very long scales, beyond which about half of the terminal joint, clothed with recumbent scales, projects; basal joint bullate, subpyriform, as broad as long, largest at the tip, with a tumid expansion at the inner part of the front; middle joint bullate, obovate, broadly and about equally rounded at either extremity, a little arcuate, twice or slightly more than twice as long as broad; apical joint seated on the middle of the tip of the second joint, straight, slender, cylindrical, scarcely tapering, blunt at tip, scarcely so long as the breadth of the middle joint and scarcely four times as long as broad.

Prothoracic lobes rather small, appressed, laminate, shaped as in *Erynnis*, but with the upper interior corner more or less angulated; more than half as long again as high and about three-fourths the length of the shorter diameter of the eye. Patagia pretty large, nearly as long as the breadth of the head, the posterior lobe fully half as broad as the base and nearly twice as long, nearly equal, straight, tapering close to the tip, which is rounded off.

Fore wing (42:8, 9) twice or nearly twice as long as broad, the lower outer angle falling distinctly though slightly beyond the middle of the costal margin; the latter straight, gently deflected at either extremity, the outer margin very gently and regularly convex, the apex produced. Costal nervure terminating at or scarcely beyond the middle of the costal margin; the subcostal nervure moderately approximated to the costal margin, the third nervure arising in the middle of the wing; cell three-fifths the length of the wing, slender, subequal in the distal half; the first median nervure arises midway between the base of the wing and the second, the latter below a point between the second and third subcostal nervures; internal nervure short, straight.

Hind wing somewhat longer than broad; the basal lobe especially much as in *Polites*, with sometimes a slight excision of the outer margin at the medio-submedian interspace. Neuration as in *Polites*.

Discal stigma of male unusually variable but consisting in the main of two separated, slender strigae of dead black scales, that in the middle median interspace linear and arcuate, that in the lower subcircular or short linear, both surrounded and sometimes almost or quite concealed by overhanging, large and broad, somewhat loosely compacted scales, and followed beyond by a field of varying size, but generally narrow, of loosely compacted, erect, dusky, reflecting scales. The scales of the stigma consist of a multitude of jointed threads and long delicately spatulate rods in the heart of the stigma, of two-pronged rods and slender, gradually enlarged scales at the base and apex of the stigma, together with many large, simple, oval scales at the base; sometimes followed in the field below the stigma by long oval scales.

Legs 2, 3, 1. Femora and tibiae clothed wholly as in *Polites*; femora 2, 13; tibiae 2, 6, 1; tarsi 3, 2, 1; tibiae and tarsi together equal on middle and hind legs. Fore and hind femora fully two-thirds the length of the middle femora. Fore tibiae scarcely two-thirds the length of fore femora, fully half as long as middle tibiae, which are scarcely longer than the hind pair. Leaf-like appendage of fore tibiae small and slender, originating in the middle of the apical two-thirds, surpassing considerably its extremity but arcuate, nearly six times as long as broad, tapering near the tip and bluntly pointed; the other tibiae armed at the tip with a pair of very long and slender greatly unequal spurs, the hind tibiae with a secondary, exactly similar, but slightly shorter pair near the middle of the apical two-thirds; both tibiae have also an exterior

row beneath of five or six long spines. Tarsal joints 1, 2, 3, 4, 5, excepting on the fore legs, which are 1, 2, 3, 5, 4. Fore tarsi two-thirds the length of the hind tarsi, which are scarcely longer than the middle tarsi, all furnished beneath with a triple row of small and delicate spines, the apical ones of each joint a little longer than the others; basal joint, excepting on the fore legs, a very little shorter than the others together; second joint scarcely more than half as long as the basal. Claws small, delicate, tapering, bent strongly in the middle and besides a little curved. Pad of moderate size, roundish. Paronychial blade, the upper lobe compressed laminate, falciform, reaching fully to the tip of the claw, twice as long as broad, not strongly curved, bluntly pointed; the lower pretty slender, equal, half as long as the claw.

Abdominal appendages: Upper organ strongly arched or bent in the middle, rather slender and nearly equal, the centrum with a deep median furrow; beyond the bend nearly straight and horizontal, the hook tapering, formed of two elements, connate, excepting at tip, where it is slightly upturned, and bearing at the extremity of the connate portion a depending, compressed, laminate, triangular tooth; lateral arms connate with the hook nearly throughout. Clasps broad, less than twice as long as broad, but as long as the upper organ, nearly equal, scarcely convex, furnished at tip, especially above, with one or two short and stout, sharp spines. Intromittent organ heavily thorned at tip.

Egg. Moderately high, broadest at the base, narrowing in the lower half very gently, in the upper half more rapidly; the summit slightly depressed over a space one-third the width of the base. Surface broken by exceedingly delicate, slightly raised lines, into roundish but somewhat angular, irregular cells; micropyle consisting first of six or eight kite-shaped cells, slightly less than twice as long as broad, arranged around a common centre, four or five of them tipped with the micropyllic canals; these surrounded by angular cells, slightly larger, and increasing but slightly in size outwardly until lost in the more distinct and larger cells covering the whole surface of the egg.

Caterpillar at birth. Head large, anteriorly appressed, broadest and truncate below, narrowed and domed above; viewed laterally somewhat cuneiform, being deepest below, gradually narrowing above; frontal triangle more than half as high as the crown. First thoracic segment with a very slight break between a triangular suprastigmatal piece and the anteriorly elevated dorsal shield. Body generally of uniform width, but very slightly arched; dermal appendages from two-thirds to three-fourths the length of the segments, the apex extending to a very slight and gradual enlargement, arranged as follows: on the thoracic segments, slightly in advance of the middle, anteriorly placed, a laterodorsal and a lateral row; on the abdominal segments a lateral series placed anteriorly; an infralateral series placed posteriorly, and on all the segments a suprastigmatal series placed centrally. Last segment with some very long, upcurved, tapering bristles.

Mature caterpillar. Head well rounded, widest in the middle, of nearly equal width on the lower half, above very regularly domed with no median excision; deepest in the middle of the lower half, somewhat plucked above; the collar scarcely perceptible; surface profusely and rather strongly and uniformly punctate; ocelli apparently five in number, three in a broad, arcuate curve, the middle one largest and nearer the upper and smallest than the lower, the fourth near the base of the antennae, the fifth above this and forming a right angle with it and the first; first joint of antennae large, mammiform; the second short, cylindrical, nearly twice as long as broad; third much smaller, cylindrical, twice as long as broad; the last a miniature of it in every particular, bearing even a short bristle; apical bristle of the third joint nearly twice as long as the antennae. Body long and slender, the terminal segment with a rather broad ovate anal plate, largest from the fourth to the sixth abdominal segments, tapering very gently in either direction; first thoracic segment with a transversely grooved thoracic shield of nearly equal width, extending from just above the spiracle on either side, the transverse groove curving forward below and partially separating a little piece about as large as the spiracle; the latter large, round ovate, elevated, crateriform; the other spiracles similar but far more minute and relatively more elongate; that of the eighth

abdominal segment again as large as the first, regularly obovate; most of the segments divided by transverse lines into sections, of which a broad one, occupying the anterior half, is partially divided by a posterior groove into a section similar to the five sub-equal ones which follow it, but the last pair of the five are again less distinctly separated than the others; whole body closely sprinkled with minute papillae, irregularly disposed, forming more than a single row upon the narrower sections and showing no tendency to a transverse disposition; a laterodorsal series of minute, crateriform disks, scarcely larger than the papillae, situated in the middle of the anterior half of each segment, and an infrastigmatal series of larger, crateriform disks, but still considerably smaller than the spiracles, halfway between them and the ventro-stigmatal fold; legs slender, the last three joints gently tapering, slightly appressed, the claw very delicate; prolegs very short.

This genus, which includes several species, is peculiar to the southern half of North America, including the Antilles and north of the tropics, but is restricted to the part lying east of the Rocky Mountains. It reaches from about the 15th to the 45th degree of latitude. Three species have been found in New England, one a very characteristic species but commoner in the north than the south, the other two in the southern portion, one not infrequently, the other as one of the rarest of our insects.

The butterflies are of small size, the male provided with a rather broad discal patch on the fore wings. They are dark brown, the fore wings with a couple of small pale spots near the middle or sometimes, in the male, with all but the outer border tawny. Beneath, the fore wings resemble the upper surface, while the middle of the hind wings is marked with a more or less feeble, yellowish, transverse belt of varying breadth.

The life histories of several species are partially, of none fully known, indicating that the species are single brooded in the north, double or triple brooded in the south, and the winter appears to be passed in some instances as a partly grown caterpillar, in others as a chrysalis. The caterpillars feed on grasses.

The eggs are white, moderately high for their breadth, and laid singly.

The caterpillar is born with a large head and an anteriorly ridged thoracic shield, with moderately long dermal appendages in lateral, infra-lateral and suprastigmatal series, and some very long recurved hairs on the terminal segments.

The mature caterpillars are long and slender, largest in the posterior half, of a dark color from a dense flecking of dark papillae, a narrow black thoracic shield, black and deeply punctate head and a very thin and excessively short pile.

EXCURSUS LXXI.—THE ACT OF PUPATION.

The butterfly has flung away
 The shell that bound it fast,
 And screened it from the chilling breeze,
 The winter's bitter blast.
 CRAWFORD.—*The Sunny Summer Months.*

THE changes undergone by a butterfly in passing from the caterpillar to the chrysalis state have always excited great interest; yet, notwithstanding all that has been written on the subject, mostly modelled upon the detailed but not wholly accurate account given more than a century ago by Réaumur, the method by which the chrysalis inclosed within the larval skin becomes attached to the silken pad into which the hindmost feet of the caterpillar had previously been plunged, has never been rightly explained until within a dozen years, when the observations of Osborne in England, and of Edwards, and especially of Riley,* in our own country, have solved the problem. The process is the most extraordinary in the higher butterflies, which suspend themselves in pupation by the hinder end only, without first spinning a loop, like other butterfly larvae, for the support of the anterior, heavier part of the body.

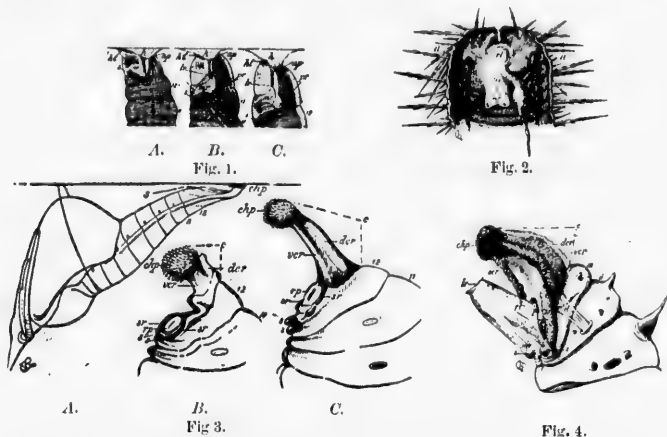
A caterpillar of this kind preparing for pupation spins a loose mass of silk in some suitable place, and, firmly attaching itself to it by the hooks of the anal prolegs and the spines at the edge of the last abdominal segment, casts itself loose from all other support, and hangs by the tail. It next curves the front part of its body upward on the ventral side, and by and by, when the front part of the body has become greatly swollen by the descent of the body fluids, and after many writhings and contortions, a rent is produced in the back of the caterpillar, and the chrysalis gradually protrudes; not as it will afterward appear, but a limp, soft, and rather shapeless mass. It now hangs at full length, and the thin integument of the caterpillar, by the shrinkage which necessarily follows its drying, aided more or less by the alternate contraction and extension of the chrysalis, creeps back toward the button of silk to which it is attached; but its terminal portion with the cremaster and the cremastral hooks, destined to be plunged in the pad of silk from which it has been suspended, still lie within the cup-shaped, crumpled pellicle; the miracle is, how it is to get outside of it and not drop to the ground; the wonder, why, when the skin has left half the chrysalis exposed, and that the stoutest and heaviest half, it does not drop out forthwith.

Réaumur gave a very circumstantial account of the changes in one of the European Nymphalidae, and his statement has been copied by many and repeated by others who have witnessed the process for themselves, but with his eyes; he asserted that the retreating larval skin was gripped be-

*I owe to Mr. Riley's kindness the cuts introduced here.

tween the edges of some of the abdominal segments, holding on by which the tail was withdrawn, then elongated and the cremaster thrust into the mass of silk prepared for it. The schematic figures, Pl. 87, fig. 20 a-c indicate this view of pupation.

This is true to a certain extent with some butterflies; that is, these actions take place, but they are not true of others and are insufficient to effect the end in all, as the seizure of the skin when it occurs is largely accidental and before it is seized the skin has so far retreated toward the tip of the body that the chrysalis would fall from its enclosure but for other important connections between the larval skin and the chrysalis.



For in the ecdysis the lining membranes of the alimentary canal and the respiratory vessels are pulled out and cast off with the old integument, and that of the intestinal tube now plays an important part, serving as a ligament to unite the two so long as union is necessary; and in addition there is secreted between the old and new membranes at the extremity of the body a mucous, which, in the parting of the two, envelopes the rectal

Fig. 1. Schematic figure of the changes in *Anosia plexippus*. A, soon after suspension; B, a few hours later, the needle separating the forming membrane from the sustainers; C, just before larval skin splits, with retaining membrane loosened and showing its connection with both larval and pupal rectum. In all the figures the forming chrysalis is shaded, and the intervening space between it and larval skin is dotted.

Fig. 2. Shrunk larval skin of *Eu Vanessa antiope*, cut open from the back.

Fig. 3. A, Chrysalis of *Xanthidia nicippe*;

B, hinder end of that of *Anaea andria*; C, of that of *Anosia plexippus*.

Fig. 4. Tail of chrysalis of *Eu Vanessa antiope*, just before withdrawal from larval skin.

The common lettering is as follows: *ap*, anal plate; *c*, cremaster; *chp*, cremastral hook pad; *dcr*, dorsal cremastral ridge; *h*, hillock or pad of silk; *hl*, hooks of hind legs; *lr*, larval rectum; *mr*, retaining membrane; *pr*, pupal rectum; *rl*, rectal ligament; *rp*, rectal plate; *s*, sustainers; *sr*, sustaining ridges; *u*, tracheal ligament; *ver*, ventral cremastral hooks.

ligament and the preanal button* or procremaster, ensnares itself in the knobs or hooks with which the latter ends anteriorly on either side, and becoming on exposure a tenacious and flexible but structureless membrane, the retaining membrane of Riley, does its share of the work to be accomplished.

It is only by much lengthening and contracting of the abdominal segments, during which the ventral side is much curved in the effort to withdraw the tail, and which make it always seem as if the skin were itself included in the telescopic action, as it sometimes actually is, that the immediate purpose of the chrysalis is accomplished. Directly, the segments are elongated and the cremaster darted as it were at the pad of silk; once a foothold or a claw-grasp here, and the rest is easy; the cremastal hooks become more and more entangled; by writhings and whirlings of the body, a greater and greater number become more and more deeply embedded, while at the same time the rapid drying of the now useless ligaments causes their rupture from the larval skin, which, shrivelled and loosened, drops to the ground, leaving the chrysalis in firm possession of the button of silk.

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 Edwards, W. H. On the pupation of the Nymphalidae. Can. ent., x: 224-231, 1878.
 Riley, C. V. Philosophy of the pupation of butterflies, and particularly of the Nymphalidae. Am. ent., lli: 162-167, 1880.

Table of the species of Thymelicus, based on the egg.

Egg nearly twice as broad as high.....	aetna.
Egg less than half as broad again as high.....	mystic.
Brettus not examined.	

Table of species, based on the caterpillar at birth.

Ranged bristles of superior rows distinctly more than half as long as a segment.....	aetna.
Ranged bristles of superior rows distinctly less than half as long as a segment.....	mystic.
Brettus not examined.	

Table of species, based on the mature caterpillar.

Front of head more or less streaked, vertically.	
Frontal triangle dark.....	aetna.
Frontal triangle yellowish white.....	brettus.
Front of head with no vertical stripes.....	mystic.

*By this term I have described in the text the often complex parts surrounding the blind rectal fissure of the chrysalis, including the ridges at the ventral base of the cremaster, those which surround the rectal fissure, and

the special parts developed on or within them or at their anterior extremity. Procremaster would be a simpler term, including all the parts in front of the cremaster or suspensory button.

Table of species, based on the chrysalis.

Abdomen greenish yellow.....	<i>aetna</i> .
Abdomen white.....	<i>brettus</i> .
Drawn up from notes of others; mystic unknown.	

Table of species, based on the imago.

Apical hook of antennal club distinctly longer than half the breadth of the club; discal stigma of male fore wings distinctly interrupted in the middle by a heavy mass of large scales.	
Under surface of hind wings with a narrow and obscure, extra-mesal stripe of lighter color than the ground; dark brown the prevailing color of the upper surface of the male; the spots at the base of the median interspaces on the upper surface of the fore wing in the female are fulvous, and rarely more pallid than the other markings, which are rarely absent.....	<i>aetna</i> .
Under surface of hind wings with a broad though obscure, extra-mesal band of lighter color than the ground; fulvous the prevailing color of the upper surface of the male; the spots at the base of the median interspaces on the upper surface of the fore wing in the female usually pallid with a tinge of fulvous, and rarely with other markings.....	<i>brettus</i> .
Apical hook of antennal club not more than half so long as the breadth of the club; discal stigma of male fore wings with no striking interruption.....	<i>mystic</i> .

GROUP I (*brettus*.)

Apical hook of antennal club longer than half the breadth of the club; first subcostal nervule of fore wings arising opposite a point midway between the base of the first and second median nervules; upper organ of male abdominal appendages extending but little beyond the claspers.

SPECIES: *aetna*, *brettus*.**THYMELICUS AETNA.—The volcanic skipper.**

(Orange brown skipper butterfly (Abbot); yellowish brown skipper (Maynard).]

- Hesperia nostradamus* Böld., Icon. Lép. 58 (1872).
 Eur., pl. 47, fig. 3 (1832).
Hesperia otho Böld.-LeC., Lép. Amér. figs. 163, 170 (1881).
 sept., pl. 77 (1833).
Pamphila otho Edw., Cat. Lép. Amer., 52
 (1877);—French, Rep. ins. Ill., vii: 160 (1878);
 Butt. ent. U. S., 315-317 (1886);—Mayn.,
 Butt. N. Engl., 62, pl. 8, figs. 98, 98 a, b (1886).
Pamphila otho var. *egeremet* Fern., Butt.
 Me., 99 (1884).
Hesperia aetna Böld., Ind. meth. eur.
 Lep., 35 (1840);—Herr.-Schaeff., Schmett.
 Eur., 1: 168, Suppl., figs. 26-28 (1843-46).
Talides aetna Böld., Buttl. Entom. monthl.
 mag., vii: 93 (1870).
Hedone aetna Scudd., Syst. rev. Am. butt.,
 nostradamus Fabr.]

I, who take root and firmly cling,
 Thought fixedness the only thing;
 Why Nature made the butterflies,
 (Those dreams of wings that float and hover
 At noon the slumberous popples over,
 Was something hidden from mine eyes,
 Till once, upon a rock's brown bosom,
 Bright as a thorny cactus-blossom,
 I saw a butterfly at rest;
 Then first of both I felt the beauty;
 The airy whim, the grim-set duty
 Each from the other took its best.

LOWELL.—The Nomades.

Imago (10: 15, 19). Head covered above with yellowish green hairs with mingled black and occasional yellow ones; the tuft at either side of the antennae mostly made of black bristles, with a few yellow ones; scales beneath the eye very pale yellowish; behind the eye nearly white, becoming lemon yellow above. Palpi very pale greenish yellow at base, becoming gradually more lemon yellow toward the tip, with longer black bristles sparsely scattered throughout; above they closely resemble the summit of the head; apical joint blackish brown behind, lemon yellow in front and at tip. Antennae above posteriorly blackish brown in rather a narrow belt, usually infringed upon on the basal half of the club by the pale yellow, which covers the rest of the antennae, excepting the apices of the joints which are largely blackish everywhere but on the club; the anterior part of the club is soft orange tawny and its apical fourth anteriorly with the crook are naked and bright castaneous, excepting the apical half of the crook which is dusky, growing blackish toward the tip. Tongue black, apical third testaceous.

Thorax covered above with mingled bright greenish and greenish tawny hairs, beneath with pale and bright greenish gray hairs, mingled in front with a few dusky ones. Femora dark purplish brown, largely flecked with greenish yellow scales upon the under half and covered with tawny scales above; tibiae tawny buff, the front brown; leaf-like appendage of fore tibiae cupreous; tarsi pale tawny buff, obscured with brownish above especially on the apical joints; spurs buff, minutely tipped with dark reddish; spines reddish testaceous. Claws reddish; pad dusky.

Wings above glistening blackish brown, the nervures marked obscurely with very dark green. *Fore wings* with a transverse series of three small, subcostal, tawny yellow spots, increasing in size downward and situated just beyond the middle of the outer half of the costal margin; also other extra-mesial spots in the median interspaces of a similar color, usually paler in the ♀ than in the ♂; the upper is triangular, occupies the base of the upper median interspace, and is usually twice as long as broad; the lower is either a slight dash in the upper part of the lower median interspace below the inner extremity of the upper spot (♂), or longer than the upper, quadrate, occupying the breadth of the interspace and situated as in the other sex (♀); occasionally in the latter sex there is a slight dash below this on the submedian nervure; these are all the markings of the ♀, but in the ♂ the basal half of the wing is largely flecked with elongated orange tawny scales, less profuse in the middle of the wing than toward either border; and below with longer scales than above. Discal stigma (43: 14; 45: 6) more complicated than in any other of our Pamphilidi, consisting of the following elements: an oval patch of velvety purplish black, baseward directed hairs, compactly clustered next the lower border of the cell, extending from the base of the upper median interspace a little more than half way to the first divarication of the median, bluntly pointed at either extremity, about four times as long as broad; a small roundish patch of similar but upward directed hairs, its diameter scarcely greater than the width of the other patch, seated in the middle of the medio-submedian interspace next the middle of the basal two-thirds of the submedian nervure, but touching neither nervure; and between them and filling a space beyond them as far as a line drawn at right angles to the nervures from the middle of the lower surface of the longitudinal patch to the submedian nervure, a somewhat loose collection of exceedingly large fuliginous brown scales, directed toward the middle of the lower edge of the collection and more or less divided into two clusters by the lowest median nervure; this is followed by a quadrate mass of partially erect, ordinary scales of a dark brown color with greenish and purplish reflections, extending along the lower median and medio-submedian interspaces, excepting the upper fourth of the former, nearly or quite half way to the outer border. Fringe dirty pale, occasionally tinged with tawny, the basal half more or less infuscated. *Hind wings* having all the central parts of the wing and sometimes the whole wing enlivened by frequent olivaceous-tawny hairs, a color occasionally partaken of to some extent by the scales and then rarely forming faint indications of an extra-mesial transverse series of spots in the middle of the outer two-thirds of the wing.

especially in the interspace beyond the cell and the adjoining ones; fringe pale tawny, the basal third dark brown.

Beneath very dark slate brown, the hind wings often tinged slightly with purplish, the markings of the upper surface repeated beneath, usually as livid, sometimes as pale tawny spots; costal border of fore wings and the whole of the hind wings dusted more or less conspicuously with olivaceous-tawny, in southern localities with ferruginous scales, giving often a very decided hue to the parts they occupy; edge of outer border delicately traced in black; fringe much as above; hind wings also furnished with a paler livid yellow or tawny, but very obscure, narrow, arcuate band of interspaceal clouded spots from the upper subcostal to the submedian nervule, in the middle of the outer two-thirds of the wing; and also with a similar small spot at the extremity of the cell.

Abdomen blackish brown above, toward the base covered with olivaceous hairs; on the sides, especially toward the tips of the joints, heavily flecked with dull tawny; beneath pale dingy yellowish, a little infuscated toward the base. Male appendages (37:15) with the united hooks of the upper organ deeply hollowed at the base above, longer than the centrum, tapering throughout, the tips turned upward more than in *bretius* but otherwise similar, and the lateral arms much slenderer, aculiform; inferior tooth more than twice as high as broad or as the height of the hook. Clasps with scarcely any excision of the borders, curving upward, but scarcely tapering and broad at tip; upper posterior angle bent inward to form a small, minutely spinigerous lobe, besides which the middle of the posterior edge bears a pretty large curving thorn, bent abruptly inward and curving slightly upward.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 14.5 mm.						
Length of fore wing.....	13.2	15.	15.52	14.5	15.	17.25
antennae.....	7.	7.6	7.8	7.	6.75	7.7
hind tibiae and tarsi..	7.25	7.25		7.5	7.5	8.5
fore tibiae and tarsi..	4.7			4.2	4.75	5.3

Described from 49♂, 30♀.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wings; the scales contained in it consist of jointed threads with rather short joints (51:5 c) situated in the heart of the stigma and accompanied by long, abruptly and minutely spatulate rods (5 k); at the tip of the stigma are found some exceedingly slender, two-pronged rods (5 h), accompanied by scales of similar length, enlarging from base to the rounded apex, but exceedingly slender throughout (5 l); at the extreme base are found only large cover scales of a more or less oval form, generally simple and rounded at the apex (5 a, b), sometimes laterally notched and roundly excised and finely striate (5 e); in the field below the stigma are found scales of varying forms with entire margins, sometimes quadrangular, two or three times longer than broad (5 f), but generally very long oval, and larger in the apical than in the basal half; sometimes very slender (5 g), at other times stouter (5 d).

Comparisons. The female of this species closely resembles that of several other of our *Pamphilid*, but may be distinguished from all with which it might be confounded, excepting the species of *Euphyes*, by the purplish tinge of the under surface of the hind wings. From *E. metacomet* it may be distinguished by the greater breadth of the vague extra-mesial, pale band of the same surface; and from *P. verna* by the lesser conspicuity of the spot in the lower median interspace of the fore wings.

Egg (66:27). The cells average .038 mm. in width, and the bounding raised lines are .0034 mm. broad; within the cells the surface is profusely dotted with shallow punctures, from .002 to .0028 mm. in width, near the summit of the egg often confluent and giving the surface a wrinkled appearance; color very delicate, pale pea green. Height, 5 mm.; width, .93 mm.

Caterpillar. *First stage* (73:11). Head piceous with sparsely scattered pale hairs, the sutures delicately marked, and that between the hemispheres punctate; mouth

parts, ocelli and antennae black, the last with a pale bristle; the mouth parts more or less tinged with reddish. Body pallid, uniformly besprinkled with round, ferrugineo-testaceous spots, which are more distinct and darker anteriorly, and grow gradually paler on the posterior segments, giving the whole body a freckled appearance; bristles from two-thirds to three-fourths the length of a segment; basal half black and straight, becoming paler and finally pellucid apically, slightly bowed, the apex very slightly and gradually enlarged; last segment with long, recurved, pointed hairs, as long as two or three segments; legs slender, equally and slightly infuscated; spiracle rims dark luteous, the larger ones blackish. Length, 2.5 mm.

Last stage (77:34). Head chocolate brown, a median darker streak down the whole front, bordered by paler stripes, but interrupted at the crown of the triangle; antennae somewhat pale. Body pale green, becoming hoary in the middle of the upper surface, but throughout profusely and nearly uniformly mottled with dark green; a dark green dorsal line, attenuated toward either end; a broad, dull yellowish green, stigmatal band, broadening so as to occupy the whole dorsal part of the body (except the dorsal stripe) beyond the seventh abdominal segment, and tinged on the posterior third of the body with very pale pinkish; a slender, indistinct, substigmatal, greenish line, followed by a yellowish green band; first thoracic segment crossed by a transverse, central, narrow black band, stopping just before the spiracles, which are in black fields; spiracles black; legs pinkish brown; prolegs green. Length, 3.5 mm.; greatest height, 5.5 mm.; breadth of head, 2.5 mm. Described from the original drawing by Abbot, in the late Dr. Boisduval's possession.

Chrysalis (85:42). Head brownish green; tongue pink; thorax dull grass green, the sutures pinkish brown; abdomen dull greenish yellow, the spiracles and cremaster dull pink. Length (total), 19 mm.; height of thorax, 4.5 mm.; height beyond wing covers, 4 mm.; length of cremaster, 1.5 mm.; length of tongue beyond wing, 8 mm. Described from Abbot's original drawing in the Boisduval collection.

Distribution (31:4). The butterfly is extremely abundant throughout the Carolinian and most of the Alleghanian faunas; in the northern half of the latter it becomes less abundant and finally disappears shortly before its ultimate boundaries. To the south it has been found even as far as Key West (Burgess); westward it has been taken on the Rio Grande (Lintner) and at Waco, Texas (Belfrage), Iowa (Austin), Lake Co., Indiana (Worthington), Wisconsin, common (Hoy), and Michigan (Mus. Mich. Univ.); and to the north it finds its limits in these latter localities, Prescott (Beadle) and London, Ontario, and Bethlehem, N. Y. (Lintner).

In New England it is confined to the southern half. Once, however, a specimen was taken in Norway, Me. (Smith). The other northern localities in which it has been found are Walpole (Smith) and Milford, N. H. (Whitney), but it is found nowhere in abundance north of Springfield, Mass. (Emery), where it is a common species.

Oviposition. The first eggs of this species seen by me were laid in confinement in a small box, and were sent me by Mr. Hambley. Most were laid on the sides but a few on the top, and one or two on the bottom of the box. Others since obtained were laid in confinement on the under surface of grass blades; they hatched early in August in thirteen days.

Food plant. Abbot figures the caterpillar on *Sabbatia gracilis*, or *S. elliottii*, one of the gentian family; but he says it feeds also on crab

grass (*Panicum sanguinale*) and other grasses; it appears to eat readily common grass.

Life history. In the north it is single brooded, appearing at midsummer. It usually makes its advent upon the wing early in July, between the 1st and the 5th, but it sometimes appears even as early as the 22d of June; a week afterwards it becomes abundant, and it continues to fly throughout July. The female commences the work of oviposition apparently about the 10th of July, and keeps it up through the month; the eggs hatch in less than a fortnight, and the caterpillar lives at least three weeks before moulting, an unprecedented length of time (in one instance from August 7 to September 3), but the further history of the insect here is unknown, though it is evident it must hibernate as a caterpillar. In the south, the insect must at least be double brooded, for Mr. Burgess took fresh specimens in Key West on the 8th of February, and Dr. Palmer poor specimens at Indian River, Florida, at the end of March, while Abbot bred a specimen in Georgia August 30, after ten days in chrysalis, and says that it is "plenty in the woods in most parts of the country in autumn." Doubtless at least another brood intervenes between these two, as is the case in its near ally, *T. brettus*.

The butterfly is less vigorous and bustling than most *Pamphilidi*, as is quickly noted by their behavior when captured. Parker notices their attraction to the flowers of Indian hemp.

Desiderata. We know far too little about the life history of this insect, and its earlier stages are little known. As it is found both north and south, and appears to vary greatly in the two regions in the number of its broods, the comparative life histories at different latitudes would be most instructive. The northern limits of its distribution should be more carefully traced, and the haunts, habits, flight and postures of the butterfly described; parasites, as usual, are unknown.

LIST OF ILLUSTRATIONS.—*THYMELICUS AETNA*.

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| <p><i>General.</i></p> <p>Pl. 31, fig. 4. Distribution in North America.</p> <p><i>Egg.</i></p> <p>Pl. 66, fig. 27. Outline.</p> <p><i>Caterpillar.</i></p> <p>Pl. 73, fig. 11. Caterpillar at birth.</p> <p>77:34. Mature caterpillar.</p> <p><i>Chrysalis.</i></p> <p>Pl. 85, fig. 42. Chrysalis.</p> | <p><i>Imago.</i></p> <p>Pl. 10, fig. 15. Female, upper surface.</p> <p>19. Male, both surfaces.</p> <p>37:15. Male abdominal appendages.</p> <p>42:9. Neuration.</p> <p>43:14. Discal stigma of fore wing of male.</p> <p>45:6. The same, greatly enlarged.</p> <p>51:5. Scales of the discal stigma.</p> <p>60:1. Side view of head and appendages enlarged, with details of leg structure.</p> |
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THYMELICUS FRETTUS.—The whirlabout.

[Black-spotted skipper (Maynard).]

Hesperia brettus Boisdu-Roche, Lép. Amér. sept., pl. 75, figs. 3-5 (1833).*Pamphila brettus* Westw.-Hew., Gen. Diurn. Lep., II: 523 (1852);—Lucas, Sagen, Hist. nat. de Cuba, 646-647 (1857);—Morr., Syn. Lep. N. Amer., 118 (1862);—Chapm., Can. ent., XI: 190 (1879);—French, Butt. east. U. S., 314-315 (1886);—Mayn., Butt. N. Engl., 62, pl. 8, figs. 97, 97a (1886).*Gemiloba brettus* Herr.-Schaeff., Corresp. zool. min. ver. Regensb., XIII: 196 (1869);—Gundl., Ent. euh., I: 164-165 (1881).*Helione brettus* Scudd., Syst. rev. Am. butt.,

58 (1872).

Isoteinon brettus Hew., Cat. coll. diurn. Lep., 228 (1879).*Thymelicus brettus* Scudd., Butt., 185-186 (1881).*Pamphila brettus* var. *brettoides* Edw., Annon. Pap. IV: 180-181 (1884).*Hesperia virginea* Scudd., Proc. Ess. inst., IV: 173-174 (1863).*Pamphila coccinea* Herr.-Schaeff., Corresp. zool. min. ver. Regensb., XIX: 54 (1864).

Figured also by Glover, Ill. N. A. Lep., pl. F, figs. 18, 19, ined.

Setzt' sich dort in warmen Sonnenschein
Auf die Stelbank.—Bienen summen,
Schmetterlinge fliegen in den
Blühenden Kastanienzweigen
Aus und ein, als wär's ein Wirthshaus.

SCHEFFEL.—*Der Trompeter von Säckingen.*

Over hill, over dale,
Thorough flood, thorough brier,
Over park, over pale,

I do wander everywhere,
Swifter than the moon's sphere,

SHAKESPEARE.—*Midsommer-Night's Dream.*

Imago (17: 11, 15). Head covered above with pale yellowish mingled with blackish hairs; behind the antennae a broad transverse band not reaching either side, of blackish brown scales; tuft on either side of the antennae of black bristles; scales on under side and behind the eye whitish becoming yellowish above the eye. Palpi whitish at base, somewhat uniform pale greenish yellow beyond, at the summit with interspersed black bristle-like scales, which also form a row around all the edge of the outer surface of the middle joint, thickest next the eye; apical joint black, flecked with yellowish in front excepting at the tip. Antennae black above, posteriorly; beneath glistening clay yellow, sometimes pale orange on the club, toward the base flecked with black and also faintly annulate with blackish toward the tips of the joints, especially on the basal half of the stem; apical two-fifths of the club beneath and the crook naked and excepting the blackish apical joint pale castaneous. Tongue dead black, growing castaneous in apical half, the tip luteous.

Thorax covered above with greenish yellow hairs, the prothorax also covered with pale orange and blackish brown scales; beneath the thorax is covered with pale yellowish hairs. Legs orange buff, the femora pale greenish yellow on the under and outer side and brownish on the inside; tibiae and tarsi pale brown above; leaf-like appendage of fore tibiae pale buff; spurs pale buff minutely tipped with luteous; spines dark luteous; claws dark reddish; pad dusky.

Wings above differing greatly in the sexes; fore wings either pale glistening orange, shading into lemon yellow above the discal stigma, the outer border bordered with dark almost blackish brown, but which is sometimes faintly flecked with orange scales; its interior limit starts from the middle of the outer two-fifths of the costal border and runs at right angles to it as far as the subcostal nervure; below this it is strongly crenulated and usually has a vague outline, its innermost limits about as far removed from the outer border as, next the costal margin, it is below the upper median nervure; above this it is removed half way to the outer border; the interspaces beyond the cell are

filled nearly to the outer bordering with a dark brown quadrate patch; outer half and sometimes the whole of the costal edge blackish, the principal veins begrimed with blackish on the basal fourth of the wing; discal stigma (43: 5) five times as long as broad, extending from the extreme base of the upper median interspace to the submedian nervure a little beyond the middle of its basal two-thirds; along its upper edge which is sinuous, formed of two convexities, it is velvety black, heavier at the extremities than elsewhere; the bulk of the stigma is gray brown sometimes ashen and is limited below by a nearly straight edge, followed by a blackish brown cloud about four times as broad as long, with a broadly rounded outer outline and composed of slightly raised scales; outer border faintly marked with a black edge; fringe of mingled dull orange and dusky scales, the latter wanting below, the basal third blackish (♂); or, very dark brown, occasionally tinged with olivaceous, with an extra-mesial row of pale yellowish or whitish spots, three of which, in the subcostal interspace, are longitudinal, very small, sometimes obsolete, the series directed at right angles to the costal border, just beyond the middle of its outer half; the others, two in number, are larger, subtriangular, at the base of the median interspaces, the upper at the extreme base, in a line directed from the outer border at the extremity of the lowest subcostal nervule to the middle of the basal half or even third of the inner border; occasionally upon the submedian nervure there is a slight streak just below the spot in the lower median interspace; outer border delicately edged with a blackish line; fringe dusky, blackish toward the base, slightly tinged with yellowish toward the tip, especially below (♀). *Hind wings* dark (♀) or blackish (♂) brown, either slightly tinged with dull olivaceous (♀) or with the central parts of the wing from the lower subcostal to the lower submedian nervule and from near the base to within an interspace's distance of the outer border almost wholly dull orange, the nervures dark and occasionally the whole slightly begrimed with dusky scales; the inner border below it covered with dull olivaceous-tawny hairs (♂); outer border very faintly marked with a blackish line; fringe either pale or orange, its basal fourth dusky (♂), or similar to that of the fore wing or slightly paler (♀).

Beneath, *fore wings* either similar to the upper surface but pale and duller, the markings not so heavy and less clearly defined, the outer border largely flecked, especially outwardly and on the upper half of the wing, with scales of the color of the ground, the basal half of the lower half of the wing blackish fuliginous and the inner margin as far as the middle of the medio-submedian interspace fuliginous; outer margin marked distinctly but delicately with a blackish brown line; fringe much as above but enlivened a little with pale orange scales on its basal half (♂); or, dark brown, hardly so dark as above, with the same markings as above, a little greenish and slightly larger, and connected in the interspaces beyond the cell by a faint cloud farther from the upper median than that from the lower median spot; the upper half of the wing, excepting in the cell, rather profusely flecked with yellowish green scales; outer margin indistinctly marked at the edge with a blackish line; fringe a little paler than above, its basal half more or less enlivened with yellowish green (♀). *Hind wings* greenish yellow (♂) or dusky yellowish green (♀), deepest in color in the centre, heavily blotched with rich dark brown tinged with reddish (♂) or obscure dark brown (♀); these blotches obscure the base and form an intra-mesal and submarginal series, the former two often coalescing so that the brighter colors form a very broad and irregular mesial belt; the intra-mesal series consists principally of two spots, a triangular, transverse patch, broadest next the costal margin and extending across the base of the lower subcostal interspace to the last divarication of the median, but often broken in the middle; and a roundish patch of about the same size filling the base of the median interspaces. The submarginal series consists of nearly equal blotches in the subcostal and median interspaces, that in the lower subcostal largest, their exterior limits an interspace's width from the outer margin. These markings are all much more strongly contrasted in the ♂ than in the ♀. Outer margin delicately edged with a dark line; fringe pale orange (♂) or dusky olivaceous (♀).

Abdomen blackish above, the sides more or less marked with tawny; beneath griny,

greenish yellow (♂) or pale grayish (♀). Male appendages (37: 27) with the upper organ having the hook equal at base, beyond tapering, shorter than the centrum, the tips bluntly pointed, parallel and slightly upturned; the free ends of the lateral arms similar but more pointed and upturned, lying directly beneath the hooks; inferior tooth as high as broad and as the height of the hook. Claspers with a considerable excision just before the middle of the lower border and just beyond the base of the upper, beyond narrowing slightly and sabre-shaped, the upper posterior angle, or the point of the sabre, bent inward and profusely covered with minute spines.

Measurements in millimetres. Length of tongue, 14 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing, ...	12.5	14.	17.45	14.	15.5	16.5
antenna	4.9	6.2	6.75	6.2	6.4	6.5
hind tibiae and tarsi, ...		7.2	7.45	7.25	7.5	7.8
fore tibiae and tarsi, ...	1.4	4.5	5.	5.	5.	5.

Described from 12 ♂, 5 ♀.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wings; the scales contained in it consist of jointed threads (30: 1 b), situated in the heart of the stigma, together with spatulate rods in the same region of varying stoutness, either very slender and with slender spatula (1 d), or much stouter with abrupt and broad spatula (1 c, e); at the extreme base are found two-pronged rods (1 f) and large and moderately slender scales (1 g) with convex, wavy, apical margin; in the field below the stigma are found some thin, large, triangular scales, finely striate without any wavy reflections (1 a).

Eggs. White, smooth, hemispherical. (Chapman.)

Caterpillar. *First stage.* Head large, black; thoracic shield black; body white. (Chapman.)

Third stage 2. Body color greenish white. Length, 13 mm. (After Chapman.)

Last stage. Head oval, rather small, black, roughened with minute granulations, the triangle, two vertical lines on the forehead and the cheeks yellowish white. Thoracic shield black, and, separated from it on either side, a black dot. Body pale glaucous green, with a dark dorsal and an obscure subdorsal and median line; posterior half of the segments transversely rugulose; spiracles minute, black. Length, 39 mm. (After Chapman.)

By way of comparison with this description, I venture to append the following from the notes of Dr. Gundlach, describing the caterpillar of the Cuban *Thymelicus cosechina*, which has latterly been regarded by Herrich-Schaeffer and Gundlach as identical with *brettus*, but which I have not ventured to so place:—Head dirty orange, posteriorly ferruginous, ferruginous also on the middle line and, separated by a yellow interval, another ferruginous line parallel to it; ocelli black; mandibles blackish. Body yellow greenish white with numerous dark points; the whole covered with white pubescence; dorsal thoracic shield and stigma and first pair of legs black; spiracles white.

Chrysalis. Pubescent, excepting the wing cases; abdomen white, the other parts pale glaucous green; eyes prominent, with a brownish spot above and a little back; on either side of head a dark point and a row of dark points along side of abdomen; wing cases smooth, faintly veined; tongue extending in a slender, free, thread-like prolongation to the tail. Length, 19 mm. (After Chapman.)

The following is a description of the chrysalis of *Thymelicus cosechina* from the notes of Dr. Gundlach:—Brownish or pale straw colored, with black on certain parts, viz., on the head, excepting the antennae; on the prothorax and mesothorax, excepting at the outer borders and along the dorsal line; sometimes on the upper surface of the abdomen and many markings on the shoulder, and sometimes above the legs; antennae and wings whiter than the body; the tongue granulated and ferruginous, extending nearly to the blackish cremaster; the prothoracic spiracle large, prominent, of a sordid yellow; other spiracles white; the dorsal surface pubescent, the pubescence closer and longer on the eyes and extremities of the body, though there is no pubescence over the ocellar ribbon, wings, legs or antennae.

Distribution (31: 5). This butterfly is a member of the Carolinian fauna and presents some peculiarities of distribution, so far as we at present know it, worthy of remark. With the single exception of a statement by Dr. Hoy that it is found rarely in Wisconsin, we know it only from various points along the sea-board. It appears to be most common in Florida, where it has been taken at Indian River by Palmer and at Appalachicola by Chapman, extends along the Gulf coast to Texas, where it is reported from near the Mexican border by both Aaron and Lintner, extends also south of our border not only on the mainland where it was brought from Saltillo, Mex. by Palmer, but also in the Antilles, being reported both from Cuba and Porto Rico. On the Atlantic coast it has been reported from Georgia and West Virginia (Edwards), but not yet from New Jersey, though I have colored this on the map.

The only locality where it is known in New England, so far, is at Farmington, Conn., where it was found by Norton.

Life history. Dr. Chapman has reared the insect from eggs found upon *Paspalum ciliatifolium* Michx., one of the Gramineae. The caterpillar "drew together the leaves of the grass, lining the cavity with silk; in this it lay concealed when not feeding, and in it all the changes were made." It feeds mostly at night.

The only data for constructing the annual history of this species are a few items mostly furnished by Dr. Chapman from notes made in western Florida. An egg laid July 4 hatched on the 10th; the caterpillar changed to chrysalis August 5 and gave the butterfly August 15. It appears to be an early butterfly in Florida, for good specimens were taken by Palmer at Indian River at the end of March. As other specimens were taken by him in Mexico early in July, we have tolerably good proof from these few facts that the insect is triple brooded, appearing in March, July and the latter part of August.

Desiderata. The meagre account we have been able to give of this butterfly, very common in the south, is sufficient indication of the need we have of further details. That it may occur in many localities at the north is indicated by its occurrence in Wisconsin and its being reported as common in Connecticut, which shows that we have yet much to learn of the distribution of this southern species.

LIST OF ILLUSTRATIONS.—*THYMELICUS BRETTUS*.

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| <i>General.</i> | Pl. 17, fig. 15. Female, half of upper surface. |
| Pl. 31, fig. 5. Distribution in North America. | 37: 27. Male abdominal appendages. |
| <i>Imago.</i> | 43: 5. Discal stigma of fore wing of male. |
| Pl. 17, fig. 11. Male, both surfaces. | 50: 1. Scales of the discal stigma. |

GROUP II (mystic).

Apical hook of antennal club only half as long as the breadth of the club; first subcostal nervule of fore wings arising opposite a point on the median nervure much nearer the base of the first than of the second nervule; upper organ of male abdominal appendages extending beyond the clasp by nearly the whole length of the lateral arms.

SPECIES: **mystic**.

THYMELICUS MYSTIC.—The long-dash.

[Orange skipper (Maynard).]

- Hesperia mystic* Edw., Scudd., Proc. Ess. Inst., III: 172-173 (1893); Proc. entom. soc. Philad., II: 15-16, pl. 1, figs. 3-4 (1893);—Pack., Guide Ins., 270-271 (1899);—Saund., Can. ent., 1: 65-66 (1899).
- Pamphila mystic* Kirby, Syn. catal. Lep., 603 (1871);—Middl., Rep. Ins. Ill., x: 97 (1881);—Fern., Butt. Me., 100-101 (1884);—French, Butt. east. U. S., 318-320 (1886);—Mayn., Butt. N. Engl., 62-63, pl. 8, figs. 99, 99 a, b (1886).
- Linchores mystic* Scudd., Syst. rev. Am. butt., 59 (1872).
- Pyrrhostidia mystic* Scudd., Mem. Bost. soc. nat. hist., II: 346, note (1874).
- Isoteinon mystic* Hew., Cat. coll. diurn. Lep., 228 (1879).
- Figured also by Glover, Ill. N. A. Lep., pl. H, figs. 2, 3, ined.

O, the heaps of sweet roses, sweet cinnamon roses,
In great crimson thickets that cover the wall!
And flocks of bright butterflies giddy to see them,
And a sunny blue sky over all.

ABBA WOOLSON.—A Summer's Day.

Imago (10:25, 26). Head covered above with olivaceous and blackish hairs, the former in excess; the eye encircled, excepting in front, with a narrow belt of yellow scales, deeper in color above than below; the tuft of bristles on either side of the antennae black, with a few short, deep yellow ones at the base behind. Palpi yellow, increasing in depth of tint apically, the tip of the second joint, viewed from above, like the upper surface of the head; a sparse row of long black hairs along the outer anterior edge of the middle joint; terminal joint black, flecked with yellowish below; antennae very pale, glistening, straw yellow below, deepening to tawny on the sides and above, and on the apical half of the joints marked with black above; the club above principally black, the inner side toward the tip and the whole of the crook naked and, excepting the dusky apical joint, dark castaneous. Tongue piceous, at tip testaceous.

Thorax covered above with olivaceous and olivaceous-tawny hairs, the former more abundant in front and mingled with some blackish hairs; below with pale greenish-yellow hairs, in front more yellowish than elsewhere; legs tawny buff, the inside of the femora more yellowish, the under surface of the same blackish, and the upper surface of the tarsi and sometimes the tip of the tibiae with a narrow, blackish line; leaf-like appendage of fore tibiae testaceous; spurs pale buff, minutely fuscous tipped; spines dark testaceous, with dusky insertions; claws reddish fuscous; pad dusky.

Wings above tawny, brighter in the ♂ than in the ♀. Fore wings bordered very broadly with dark lustrous brown, with obscure, very dark green reflections, most broadly bordered in the lower half of the wing, where the interior margin of the bordering crosses the middle of the outer two-thirds of the submedian nervure; in the upper half it is hollowed, approaching a little nearer the outer border in the interspace beyond the cell; the basal portions of the same interspace, and especially its upper half, are occupied by a longitudinal, dark brown patch, which generally reaches or just fails of reaching the outer bordering—at least in the upper half, the lower border of the patch scarcely reaching the upper median nervule, at least in the outer half. In the ♀ this patch is accompanied above its basal half by a secondary patch, a little

tinged with ferruginous, extending nearly or quite to the costal border, generally narrowing as it goes; traces of this patch are seen in the ♂, but they are generally confined to the immediate border of the larger patch. In both sexes, but especially in the ♀, the base of the wing, especially along the nervures, is begrimed with dusky scales, and the nervures in the outer half of the wing are usually traced with dusky scales; in the ♀ the basal obscurity is accompanied by a large, triangular, dusky patch, often flecked a little with tawny scales, extending from the cell to the submedian nervure, and from the base of the wing to the last median divarication, where at its upper outer angle it connects with the other patch; the inner margin below the submedian is also dusky. In the ♂ the discal stigma (43:6) consists of a very slender, slightly sinuous stripe, extending from the last divarication of the median nervure to a point on the submedian a little beyond the middle of its basal two-thirds; it is fourteen times longer than broad, and consists mainly of short, erect, very closely compacted, delicate, blackish brown hairs; but at its outer extremity and upper edge, following the median nervure, from its last divarication halfway to its first, is a line of slightly more elevated, purplish black, slender scales; the stripe is followed on its under outer surface by a rounded, moderately broad patch of soft dark brown, slightly raised scales, which does not quite reach either extremity of the patch, is less than half as high as broad, and is cut in the middle by the lower median nervure, which sometimes divides it into two symmetrical, rounded patches, united to a greater or less extent by the adjacent borders. The costal edge is occasionally marked with dark brown; the edge of the outer margin is delicately traced with a blackish line; the fringe is dingy pale, often suffused slightly with yellowish, overlaid at base by dusky scales, and often obscured by dusky to a greater or less degree on the upper half. *Hind wings* broadly bordered around the entire wing by dark brown, and crossed in the middle by a belt of the same, so that they may better be described as dark brown with an extra-mesial band and intra-mesial spot of tawny, often largely obscured, especially in the ♀, and crossed by dusky nervures; the spot occupies the outer half of the cell and is almost always largely obscured; the band extends from the upper subcostal to the lower median nervure, and sometimes to the middle of the medio-submedian interspace, and varies in width from scarcely more than the width of one to that of two or three interspaces, and occasionally, especially in the ♂, extends so far toward the base that the dark parts lying between it and the cellular spot are reduced to a narrow, dusky bordering of the cell; usually the outer border is slenderly edged with blackish; the fringe is as in the fore wings, its basal fourth dusky.

Beneath orange buff, occasionally tinged slightly with cinnamonaceous (♂), or tawny cinnamonaceous, the fore wings at least more or less infuscated (♀). *Fore wings* more deeply tinted along the costal border than elsewhere, the paler parts of the upper surface adjoining the outer bordering repeated beneath, but still paler, while the other markings are similar; the outer border is delicately marked with a blackish edge, and the fringe is nearly uniform pale brown, tinged according to the sex with the ground color of the wing. *Hind wings* with yellow markings, which are inconspicuous, sometimes scarcely discernible in the ♂, distinct or indeed conspicuous in the ♀; they consist of a moderately large spot at the tip of the cell and a rather broad, equal, strongly sinuate or bent extra-mesial belt, extending from the costal nervure to the middle of the medio-submedian interspace, crossing the upper median interspace about midway between the base and tip, the exterior border of the band lying, as a rule, about half way between the interior border and the outer margin of the wing; the inner border, as far as the submedian, and especially on the outer half of the wing, is usually a little paler than the other parts, especially in the ♀; the edge of the outer margin is sometimes traced delicately in black, and the fringe resembles that of the fore wing or is a little paler.

Abdomen blackish above, covered rather profusely with long, tawny hairs, becoming thicker and clearer toward the tip of the abdomen, and on the apex of the joints on the sides; beneath a little paler than the under surface of the wings. Male appendages (37:31) with the upper organ very long, extending far beyond the clasps, the

hook twice as long as broad, equal on the basal half, tapering on the next quarter only, blunt, attinent and upturned at the tip; lateral arms perfectly connate with the hook throughout. Clasps more than half as long again as broad, nearly equal, a little concave beyond the middle below, the lower posterior angle very fully rounded, the upper posterior angle produced to an incurved, depressed spine, overlaid by the incurving upper posterior lobe, which resembles it on a larger scale.

Measurements in millimetres. Length of tongue, 15.25-18.5 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	13.5	15.	15.25	14.75	16.	16.5
antennae.....	6.	6.5	6.75	6.75	6.75	6.8
hind tibiae and tarsi..	7.15	7.8	8.		8.6	8.75
fore tibiae and tarsi..	5.	5.2	5.5	5.	5.	5.4

Described from 49♂, 29♀.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wings; the scales contained in it consist of very slender, jointed threads, the joints faintly fusiform (50:3 b) and of spatulate rods or scales, the spatula more or less gradually developed (3 c, e), found in the heart of the stigma; at the extreme base some subfusiform, two-pronged, slender scales (3 f), as well as scales of large size, either enlarging gradually from base to apex (3 g), or equal throughout (3 d); the truncate apical margin more or less abruptly waved; in the field below the stigma are found some long, triangular scales, finely striate, with waved reflections which converge more rapidly next the base than at the apex, where they are nearly longitudinal.

Melanio variety. THYMELICUS MYSTIC WEETAMOO. Mr. Lintner has obtained a single specimen which appears to be a melanic form of the ♀. It is of a nearly uniform, dark, lustrous brown, the basal half of the fore wings with a warm flush caused by a rather liberal sprinkling of tawny scales; the yellowish markings of the fore wing of the normal type are present in a greatly reduced form, closely resembling those of *L. manataqua*, and consisting of a small spot at the tip of the cell, and similar, nearly equal spots in the middle of the outer half of the wing, three depending from the costal margin and one near the base of each median interspace; on the hind wings the cellular spot is indistinct and the extra-mesal band narrow and broken into vaguely defined spots. Beneath, it differs from the normal type in no way excepting in the diminished extent of the extra-mesal markings of the fore wing.

Diffused variety. THYMELICUS MYSTIC NUBS. A female under examination has the upper surface of the fore wings almost uniformly flecked throughout with tawny scales on the basal half, and with tawny yellow scales on the outer half, excepting for the following markings: the usual dusky patch in the interspace beyond the cell, which here extends over the extremity of the cell, and includes there a small quadrate yellow spot, and a continuation of the same below the cell corresponding to the outer parts of the usual patch at this place; the middle of the outer half of the wing has a transverse series of yellowish spots, larger than those described in the melanic female, but much smaller than the normal type, and with confused borderings, especially outwardly. The hind wings have only a flecking of tawny yellow scales in the outer half of the wings, which, with the greenish tawny scales which give the whole wing an olivaceous appearance, slightly contrast with the grayish aspect of the fore wings.

Beneath, the wings are nearly of a uniform, very pale grayish fulvous, but the under half of the fore wings, except outwardly, is slate brown, and the light spots of the upper surface of the fore wings are repeated, rather faintly, beneath, while a row of similar, faint, obscure dots represent the position of the extra-mesal band on the hind wings.

Egg (66:20, 24). Cells irregularly hexagonal, averaging .03 mm. in diameter, their surface uniformly covered with exceedingly delicate, frequent punctuations; inner cells of micropyle (69:13) eight in number, kite-shaped, .0113 by .021 mm. in size, every alternate one furnished with a micropylar canal at outer extremity; these are followed by pretty regular, hexagonal cells at first longer than broad, .019 by .025 mm., increasing slightly in size away from the centre, until they merge almost insensibly in

the common cells, the limits being distinguishable only by a slight change in the contour of the egg, the punctuations extending also upon the micropyle; color very pale green. Height, 7 mm.; width, .92 to .96 mm.; width of micropyle, .322 mm.

Caterpillar. *First stage.* Head shining piceous or bronze black with a few broad, very shallow, irregular, impressed streaks and distant, minute, and shallow, circular punctae, each giving rise to a short, pale hair; ocelli black; mouth parts very dark reddish. Body very pale greenish yellow, almost white; first thoracic segment slightly discolored with reddish brown and the shield piceous, broader in the middle than at the extremities; bristles straight, .07 mm. long, nearly equal as far as the slightly thickened and truncate tip; those of the subdorsal row are inclined inward so much that their tips nearly meet; last segment with two pairs of subdorsal hairs .25 mm. long, erect and considerably recurved; first pair of thoracic legs blackish fuscous; legs very pale greenish; claws not infuscated; prolegs the color of the body. Length, 3 mm.; breadth of head, .58 mm.; of body, .48 mm.; length of thoracic shield, .07 mm.

Second stage. Head (80:58) shining piceous with a few short, inconspicuous, delicate pale or whitish hairs; mouth parts black. Body clear grass green, paler or dirty pellicud beneath and toward the tail; a slightly darker dorsal line; anterior half of the first thoracic segment brownish fuscous; the mediodorsal line white; posterior third covered with an unbroken, black dorsal shield broader than the base of the fore legs, reaching as far as the legs which are also black; the other thoracic legs are green, a little obscured, infuscated or blackish at tip. Body covered profusely with blackish specks arranged in transverse rows, from each of which springs a very pale short hair; each of the shorter sections contains a single transverse row of these specks, regularly disposed, but the broader, anterior section contains a large number irregularly disposed but forming in a general way three transverse bands; anal plate with a few longer hairs; prolegs green; first pair of spiracles blackish; the last pair dark castaneous; the others greenish. Length, 6 mm.; breadth of body, 1.25 mm.

Third stage. Head piceous, delicately shagreened, covered not very abundantly with exceedingly short brownish pile; lower part of head next the blackish mouth parts tinged with reddish. Body dull yellowish brown tinged with greenish, especially noticeable along the slender greenish dorsal line, where the body is less bespecked with the minute brownish dots everywhere sprinkled over the surface, giving rise to exceedingly short, delicate, brownish hairs resembling pile; tip of body brownish; thoracic shield black, broad, equal, reaching to and including the spiracles; the portion of the segment in advance of it, pale, tinged with purplish at the neck; first thoracic legs black, the others greenish, a little infuscated; prolegs greenish yellow; spiracles blackish fuscous. Length, 9.25 mm.; breadth of body, 1.25 mm.

Fourth stage. Head (80:59) piceous, delicately and rather deeply vermiculate, with a few scattered pale hairs; in some specimens the head seems to be tinged rather deeply with red; antennae black, bristle white; ocelli black; jaws black. Body dull castaneous brown with excessively pale mottlings and bestudded with black speck-like papillae scattered over the surface but usually confined to the paler parts; each gives rise to an exceedingly short and delicate pale hair; a dark brown dorsal stripe, and a very faintly indicated, dusky yellow, infrastigmatal line, posteriorly obsolete; thoracic shield black, the portion of the segment in advance whitish; first two pairs of thoracic legs blackish fuscous; third pair pale, infuscated; prolegs of the color of the body; stigmata black. Length, 11 mm.; breadth of head, 1.35 mm.; of body, 1.75 mm.

Last stage. Head not large in proportion to the size of body, but prominent and much larger than the first thoracic segment, dull reddish brown, edged with black posteriorly, downy, with very minute, whitish hairs. Body onisciform, above semi-transparent, dull brownish green, downy, with fine whitish hairs similar to those on the head, with a dorsal line and many dots over the surface of the body of a darker shade; first thoracic segment pale whitish with a line of brownish black across the upper surface; terminal segments paler than the rest of the body; under surface slightly paler than upper with a semi-transparent glossiness; feet and prolegs whitish. Length, 25 mm. (After Saunders.)

Distribution (31:6). This butterfly must be considered a member of the Alleghanian and Canadian faunas, although it scarcely reaches the extreme limits of either. Southwardly it is found as far as Staten Island (Davis), Pennsylvania (Blake, Mus. Amer. Ent. Soc.) and Maryland (Scudder); and to the north it has been taken in Nova Scotia, "common" (Jones), Ha Ha Bay and Cacouna (Saunders), Quebec, "not uncommon" (Bowles), Montreal, not common (Caulfield, Couper), Chateauguay (Pearson), and Ottawa, Canada, very common (Billings, Fletcher). West of eastern New York, Bethlehem, Albany, Schoharie (Lintner) and the Adirondacks (Hill), it seems to have been seldom reported, although Hoy finds it common in Wisconsin, Worthington says it occurs in northern Illinois, and Edwards gives it from Michigan and Canada West. Mr. Saunders, however, has not detected it in Ontario. In 1888, since the map was printed, Mr. Fletcher and I found it common at Nepigon.

In New England it occurs everywhere, from the White Mountains (Scudder) and Pinkham Notch, N. H. (Sanborn) and Orono (Fernald) and Hallowell, Me. (Miss Wadsworth), to Cape Cod (Fish) and New Haven (Smith, Mus. Yale Coll.). There is hardly a local collection of any size which does not contain it, but it is much less common in the southern than in the northern half and it is rather rarely found in the vicinity of Boston; nor have I taken it at Nantucket.

Oviposition. The eggs are very lightly affixed to blades of grass, at least in confinement over the same, so lightly that they often readily drop to the ground on jarring the grass; in several instances the females have been known to lay eggs when enclosed alive in pill boxes and then unaffixed, or it may be so loosely attached as to fall on opening the box. Mr. Saunders had the eggs hatch in eight or nine days in London, Ontario, at the end of June; near Boston in June and July I have found the period ten or eleven days, in the White Mountains generally about thirteen days. Eggs laid at Nepigon and carried to Ottawa and Boston took twelve to fourteen or more days to hatch.

Food and habits of the caterpillar. The natural preference of the caterpillar is not known, but it readily feeds upon common grasses and its habits are very similar to those of *Atrytone zabulon*. It devours its forsaken shell as soon as hatched. It is timid and retires abruptly at the least alarm to its tubular nest of grass blades, which is firmly constructed of many blades and many threads, some of the openings being covered with a gauze-like framework somewhat resembling that of the cocoon of the geometrid moth, *Zerene catenaria*. It is slow to mature, several weeks being passed in each larval stage, so far as my experience has gone, though Mr. Saunders carried one from egg to chrysalis in about forty days.

Life history. The data at command for establishing the periods of the apparition of this butterfly are insufficient to enable one to speak with

confidence. The indications are that it is double brooded in the southern and single brooded in the northern part of New England. In the extreme south of this district the first butterflies make their appearance in the earliest days of June, perhaps even in May; fresh specimens continue to emerge during the first half of June, but by the middle of the month they begin to decrease and appear rubbed; they lay their eggs at least as early as this, and have disappeared by the end of the first week in July, usually before the end of June. The eggs are hatched in from eight to eleven days, but the caterpillars do not seem to be very uniform in their growth, some attaining full size only in October and passing the winter in this stage, others changing rapidly (as shown by Mr. Saunders's experience) and producing a second brood of butterflies, the earliest of which appear from the 7th to the 10th of July, laying their eggs within at least a fortnight afterwards, and continuing on the wing sometime into September; the eggs are hatched in ten or eleven days; probably the caterpillars from them attain maturity before winter, but they very likely vary in this respect. Passing northward, the butterflies of the first brood do not seem to make their appearance in such elevated places as Williamstown, Mass., for example, before the 10th or 12th of June, and it may be that no second brood makes its appearance; still further north, among the White Mountains and at Nepigon, it is certain that there can be but a single brood, for the butterfly does not make its appearance until the first week in July—a few days only before the advent of the second brood in southern New England. Eggs are here hatched in about thirteen days and caterpillars go into hibernation, in some instances, perhaps always, in their third stage, toward the end of September.

Habits of the butterfly. The butterfly frequents open grassy fields and like its fellows is very fond of flowers. Guignard tells how he found a lady's slipper, *Cypripedium spectabile*, in which this butterfly with two other skippers almost entirely filled up the great bowl to the lip. When at complete rest its wings are all tightly closed, the base of the costal edges of the hind wings just meeting the costal edges of the fore wings; the antennae, viewed from above, are curved a little and regularly, the convexities outward, their general course making a divergence of from 155° to 165° and the tip of the club turned at right angles backward. When a little alarmed it moves one antenna backward and forward a little; when alarmed but still resting, the antennae are brought nearer together so as to be at an angle of about 135° apart; viewed from the side they are quite straight and barely raised above the plane of the body, which itself is elevated about 30° .

Desiderata. The history of this butterfly is still obscure and needs careful investigation in many places before it can be established. It is especially desirable that it should be followed carefully in the southern part

of its range, where it is probably in part single and in part double brooded, to learn in what condition or at what stages the winter is passed and whether all caterpillars behave alike. Nothing is known of the chrysalis, excepting that Mr. Saunders reared it the same season from caterpillars produced from eggs laid in June; the flight of the butterfly is undescribed and any parasites of the insect are unknown.

LIST OF ILLUSTRATIONS.—THYMELICUS MYSTIC.

General.		Imago.	
Pl. 31, fig. 6.	Distribution in North America.	Pl. 10, fig. 25.	Male, upper surface.
Egg.		26.	Female, both surfaces.
Pl. 60, fig. 20.	Egg.	37: 31.	Male abdominal appendages.
24.	Outline.	42: 8.	Neuration.
60: 13.	Microscopically.	43: 6.	Discal stigma of fore wing of male.
Caterpillar.		50: 3.	Scales of the discal stigma.
Pl. 80, figs. 54, 59.	Front views of head in stages II and IV.	60: 2.	Side view of head and appendages enlarged, with details of leg structure.

LIMOCHORES SCUDDER.

Limochores* Scudd., Syst. rev. Amer. butt.,
59 (1872).

Hesperia pars Auctorum.
Pamphila pars Auctorum.

Type.—*Hesperia manataqua* Scudd.

The groves are full of song-birds,
And troops of butterflies
Are hovering o'er the peach-trees,
Like blossoms of the skies.

STODDARD.—*Chinese Songs*.

And, which was strange, the one so like the other
As could not be distinguish'd but by names.

SHAKESPEARE.—*Comedy of Errors*.

Imago (60: 5). Head large, heavily clothed with rather short hairs, arranged in long transverse masses; just outside of the antennae a small, spreading, compressed tuft of arcuate hairs, passing generally but one-fifth, occasionally more than one-fourth, way around the eye. Front protuberant, tumid, wholly and considerably surpassing the front of the eyes, pretty regularly and considerably arched both transversely and longitudinally but slightly flattened in the middle; shallow, obliquely longitudinal sulcations occur on either side in front of the inner edge of the antennae; the whole piece from two and a half to three times as broad as long, the front border delicately margined and in the middle slightly and roundly excised, the outer anterior angles very broadly rounded off; separated from the vertex by a slight shallow sulcation, nearly straight, but barely inclining backward at the extremities where it ends in the middle of the antennae. Vertex rather tumid, slightly or considerably elevated above the level of the eyes, sometimes throughout, but generally on the anterior half only, and sometimes with a distinct, transverse, median ridge; scarcely arched transversely, separated from the occiput, which is scarcely sulcate longitudinally in the middle, by a slightly impressed, brace-shaped line. Eyes large, pretty full or full, nearly circular, naked. Antennae inserted with their hinder edges in the middle or scarcely behind the middle of the summit, separated from each other by from three to nearly four times the diameter of the basal joints, the whole antenna slightly or a little shorter than the abdomen, composed of from forty-two to forty-four joints, of which from seventeen to twenty-two form the club which, although always containing as many

*Λεμῶν, χορεύων, one that dances over meadows.

joints as the remainder of the antennae and almost invariably a few more, is only about two-thirds as long as it; the crook excluded, proportionally longer and slenderer in the larger than in most of the smaller species, being about four times as long as broad, pretty stout, oval, increasing in size pretty gradually on the basal half and at the extremity much more rapidly, bluntly rounded in the smaller species; from five to six times as long as broad, moderately slender and cylindrical, increasing in size very gradually at the base, more broadly but less rapidly in the larger species than in the others, in both largest about the middle of the apical half; the crook exhibits similar differences in the two sections, being composed in the smaller species of only five or six joints and forming an appendage, tapering pretty rapidly, about twice as long as broad and considerably shorter than the breadth of the club proper; while in the larger butterflies it is composed of seven joints and forms a long and slender, gradually tapering appendage three or four times as long as broad and considerably longer than the breadth of the club; middle joints of the stalk generally three times as long as broad but in some of the largest species only twice as long as broad; the third from the base rather less than four times as long as broad. Palpi rather short and very stout, from one and a half to two times the diameter of the eye, heavily clothed with a mass of not very long scales, appressed on the apical half of the palpus, beyond which about half of the terminal joint, heavily clothed with recumbent scales, more or less distinctly protrudes; basal joint bullate, subpyriform, a little appressed, as broad as or broader than long, with a tumid expansion inwardly at the extremity; middle joint large, bullate, obovate, broadly and about equally rounded at either extremity, generally a little largest at the distal extremity, nearly straight, about as broad as the basal joint and about twice as long as broad; terminal joint seated on the middle of the extremity of the second joint, straight, sometimes cylindrical, very bluntly pointed at the extremity, at others largest just beyond the base and tapering equally to a rather blunt point; generally about three times as long as broad but in the largest species, where it is nearest cylindrical, fully four times as long as broad and as long as the breadth of the middle joint, while in the others its length is but three-fourths the breadth of the middle joint.

Orthosternite lobes rather small, appressed, laminate; when viewed from the front, subtriangular, the inner and lower edges nearly straight and at right angles, the upper outer edge strongly arcuate, a little bent in the middle, the whole piece varying in height from half as long again as high, to scarcely longer than high, in all cases about as long as the shorter diameter of the eye. Patagia pretty large, very nearly as long as the breadth of the head, the posterior lobe half as broad and fully half as long again as the base, in the smallest species equal, tapering only next the rather broadly rounded tip, in the larger ones and those of medium size distinctly tapering throughout, the tip bluntly rounded.

Fore wing (42:18) twice as long as broad or scarcely less than that, the lower outer angle falling slightly beyond the middle of the costal margin, particularly in the females; the costal margin straight excepting for the slight apical deflection; outer margin regularly and slightly convex. The costal nervure terminates a little beyond the middle of the costal margin; the subcostal is tolerably close to the costal margin, its second nervule arising scarcely before the middle of the wing; cell fully three-fifths as long as the wing, rather slender, produced in the middle of the apical half which is subequal. First submedian nervure arising considerably nearer the second than the base of the wing, the second about opposite the second subcostal nervure; internal nervure short, straight.

Hind wing slightly longer than broad, shaped almost exactly as in *Polites* but more uniformly rounded. Subcostal and median nervures first forking at equal distances from the base at the middle of the basal two-thirds of the wing.

Discal stigma of male very simple, consisting of two nearly equal, short, nearly continuous, straight strigae in the lower two median interspaces, the upper one often arcuate and sometimes the latter in a reverse sense, formed of dead black, sub-erect or retrorse rods, with very slight peculiarities in the margination, the subjoined area

of erect and loosely compacted scales entirely inconspicuous. The scales found in the heart of the stigma consist of jointed threads, composed of seven or eight joints, two-pronged, slender scales at the extreme base of the stigma, accompanied by oblanccolate scales here and at the tip of the stigma, while as special androconia occur many spatulate rods.

Legs 2, 3, 1. Femora and tibiae clothed as in *Polites*. Femora 2, 1, 3; tibiae 2, 3, 1; tarsi 3, 2, 1. Fore femora scarcely longer than the hind, two-thirds the length of the middle femora. Fore tibiae less than two-thirds the length of the fore femora, three-fifths the length of the middle tibiae, which are scarcely longer than the hind pair and but little longer than the fore femora. Leaf-like appendage of the fore tibiae rather small, long and very slender, originating a little before the middle of the outer two-thirds of the joint and surpassing its tip considerably, but much curved and tapering almost throughout to a blunt point, about five or six times longer than broad; other tibiae armed at the tip with a pair of very long and slender, very unequal spurs, the hinder tibiae also with a secondary pair of similar but scarcely shorter spurs in the middle of the apical two-thirds; both tibiae, but most conspicuously the middle, with an inferior outer row of four or five long spines, less conspicuous in some species, and especially the larger, than in others. Tarsal joints 1, 2, 3, 4, 5, excepting the fore legs, where they are 1, 2, 3, 5, 4. Fore tarsi three-fourths the length of the middle tarsi, which are scarcely shorter than the hind tarsi, all furnished beneath with a triple row of pretty long and slender spines, the apical ones of each joint a little larger than the others; basal joint scarcely longer than the second, third and fourth together, excepting on the fore legs of the largest species, where it nearly equals the rest of the tarsus; second about half as long as the basal joint. Claws small, delicate, tapering, pretty strongly arcuate, finely pointed. Pad generally pretty large, tumid. Paronychia as in *Thymelicus*.

Abdominal appendages: Upper organ similar to that of *Thymelicus*, though nearly destitute of an inferior tooth. Clasps broad, a little convex, about twice as long as broad and approximately sabre-shaped, being curved a little upward and always produced to a point at the apex above, unprovided with bristly spines. Intromittent organ furnished at tip with lateral curving laminae beset with long pointed spines.

Egg. Not very high, broadest at base, above it at first scarcely narrowing, broadly domed above, the extreme summit nearly flat over a space less than half the diameter of the base. Surface broken by very delicate but distinct raised lines into pretty regularly pentagonal cells of very small size, punctate within. Micropyle very slightly sunken in a shallow saucer-shaped depression, consisting of eight or nine kite-shaped cells concentrically arranged, followed by as many angular cells of twice the size and these by still larger, gradually and very soon merging into the ordinary cells of the upper surface, which are larger but no more distinctly marked.

Caterpillar at birth. Head appressed, globose, fully half as broad again as the thoracic segments. Body broadest on the front abdominal segments, but almost parallel sided, well rounded above, rather flattened beneath. Dermal appendages (86: 52, 53) arranged in the following series: a laterodorsal, turned inward, one to a segment, anteriorly placed, becoming subdorsal and centrally placed on the thoracic segments; a lateral, one to a segment, posteriorly placed on the abdominal, centrally placed on the thoracic segments; a suprastigmatal, one to a segment, placed just in advance of the middle; and an infrastigmatal, two to a segment in the abdominal region, one placed anteriorly, one centrally, one to a segment anteriorly placed in the thoracic region.

Mature caterpillar. Body largest on the fourth to fifth abdominal segments, tapering toward either extremity, the head no larger than the second thoracic segment. Without longitudinal markings except the dorsal line due to the dorsal vessel and a slight stripe along the infrastigmatal fold; covered profusely with minute wartlets to which the coloring is largely due. Thoracic shield conspicuous, reaching from just above the spiracle of one side to the same point on the other. There are two series of crateriform or lenticular disks down the sides of the body, probably laterodorsal and laterostigmatal. This description is necessarily very imperfect.

Chrysalis. Viewed from above, broadest at the third abdominal segment, tapering very gradually forward to the basal wing tubercle, in front of which it is narrowed rapidly to the anterior extremity of the thorax; prothorax narrower than the head by being overlapped by the antennal sheaths; front broadly and considerably rounded, the eyes slightly fuller, disturbing the curve but little; posteriorly the abdomen tapers much more rapidly and pretty regularly, having a somewhat conical form, to the subtriangular cremaster; viewed laterally, the under surface of the body is nearly straight, though slightly full, from the front to the tip of the wings; front slightly but roundly angulated below the eyes and at the extreme front in front of their upper margin; dorsal curve of head and thorax uniform, gentle, highest beyond the middle of the mesothorax; abdomen equal on the basal half, subconical apically; prothorax with a sinuate, posterior border, the mesothorax being broadly advanced in the middle anteriorly, and again at the spiracles, while receding between; spiracle guards large, fabiform, prominent, front edge straight, covered with exceedingly minute, conical protuberances; second and third abdominal segments very long, nearly twice as long as the first, the fourth nearly twice as long below as above, the wing cases reaching a little beyond its middle; antennae with the tapering tip reaching, with the first pair of legs, almost as far as the cell of the wing; the middle legs almost reaching the extremity of the upper wing case; the hinder legs reaching the hinder margin of the fifth abdominal segment and the tongue that of the seventh abdominal segment; a subdorsal anterior and supralateral post-median or posterior series of minute, elevated, rounded or transversely oval disks on the abdominal segments, the relics of the crateriform disks of the larva. Body strongly pinched on either side at the base of the abdomen so as to produce, especially by a dorsal flattening, an arcuate and rather prominent ridge following the whole inner margin of the wings; cremaster formed of a depressed plate, thickened at the edges, which are obliquely depressed over a broad field above, triangular, tapering more rapidly in the apical than the basal half, sulcate both above and below, especially the latter; cremastral hooks few in number, wholly apical, the stem not very long, the tip expanded and tightly curled, their hold upon the silk apparently aided by long, recumbent bristles at the base of the cremaster.

This genus, numerous in species, is confined to eastern North America, between latitude 30° and 45°, i. e., east of the Rocky Mountains from Nova Scotia to Florida. It is not known on the Pacific slope. The species differ from each other to an unusual extent, especially the larger, which are found mostly in the south, from the smaller, which are more commonly restricted to the north. Four of the species occur in New England, one of them is found throughout its extent, in great abundance, while the others occur only in the southern half and are relatively rare.

The butterflies are either of small or of rather small size, the fore wings of the males provided with a moderately long, sometimes rather stout, discal streak. The wings are dark brown, with but slight and feeble markings, usually confined to a dull tawny patch on the costal border, or to a transverse series of spots on the outer half of the fore wings. They are nearly uniform below.

The transformations of several species are known. The insects are sometimes single, sometimes double brooded and all probably pass the winter in the chrysalis state. The butterflies may be found flying swiftly about open sunny meadows. They rest with the fore and hind wings at different angles.

The caterpillars feed principally on grasses, constructing between the blades a feeble gauze-like tubular nest, in which they remain when not feeding; their habits are very similar to those of the species of *Atrytone*. Abbot and Chapman have found the southern kinds on *Dichromena*, *Cladium* and *Zizania*, besides on *Sabal*, one of the *Palmae*, and even on *Tragopogon* (salsify) one of the *Compositae*. Boissduval and Le Conte figure *L. arpa* on *Dichromena leucocephala*, the saw grass, but Dr. Chapman reared it on the saw palmetto, *Sabal serrulata*, and thinks it does not live on the former, though *L. palatka* does; Abbot in his notes gives both *Dichromena* and *Tragopogon mutabilis*.

The eggs are not very high, and arch from the very base. The caterpillars when born are unusually slender, with moderate dorsal bristles, but exceptionally long ones on the last segment, twice as long as the width of the body. The mature caterpillars are moderately slender, almost equal sided but largest behind the middle, griseous, with black heads and thoracic shields, the latter in a pallid setting. The chrysalids are moderately slender, green and gray, with broad, well rounded heads, tongues which extend to the end of the seventh abdominal segment, and strongly depressed, almost laminate cremaster.

In his recent lists Edwards has curiously separated the species of this group (which are very closely allied) by wide intervals, interpolating between them forms with very different structure, such as *Euphyes*, *Calpodus*, *Oligoria* and *Lerema*, for which he gives no reason whatever. It is a good illustration of the small attention given to the structure of these insects.

EXCURSUS LXXII.—THE LAWS OF COLORATIONAL PATTERN.

. . . The butterflies,
Crimson and blue and amber—flitted thick.
ARNOLD.—*The Light of Asia*.

It is not simply by the similar character of the minuter structure of the body,—the form and jointage of the antennae and palpi, the neurulation and shape of the wings, or the armature of the legs, that neighboring butterflies show their relationship to one another. To an equal degree this affinity appears in the disposition of the colors upon the surface of the wings. In general, therefore, but of course with some exceptions, the affinities of a strange butterfly may be told by an expert at a glance; its very livery betrays its origin. Nor is it strange that this should be so. One of the characteristic features of the *Lepidoptera*, of which the butterflies are the highest expression, is their possession of broad membranous wings covered with pigment-bearing scales, and it is through the varied development and distribution of that pigment that natural selection has had the best chance to work.

When by a different mode of life or by being confronted with new emergencies or by any other change in the environment, a chance has offered for new structural adaptations, then has been the most favorable time in a given type for a more or less marked divergence in pigmental distribution from others of its brethren which are following a different track and trying another chance in life. So it comes about that color and color patterns have assumed a definite relation to genera and tribes and sometimes even to subfamilies, the most marked case of the latter, perhaps, being the prevailing subdued brown monochrome of the upper surface of the wings of the Satyrinae and the prevalence on their under surface of ocellated markings.

Other examples which run through whole tribes or prevail in them are seen in the Vanessidi with the marmorate markings of their under surface; the Argynnidi with their large silvery nacreous or greenish nacreous spots in concentric rows on the same surface, or the fulvous upper surface blocked with black; the Theclidi with their upper surface monochrome or with only two colors displayed in masses and the markings of the under surface transversely linear and most delicate; the Lycaenidi with their affection for pale or silvery blue and their markings beneath mostly in tiny circlelets, lunules or points arranged transversely. So, too, the orange and yellow of the Rhodoceridi, the white of the Pieridi and the black margined fulvous of the Pamphilidi are cases in point. To enumerate or to merely begin to enumerate the genera were a wearisome task. The tessellated *Hesperia* is a sufficient example.

Since in a large number, perhaps the vast majority, of cases, the pattern of the under surface of the wings is protective and is markedly similar in a great variety of allied forms (witness the *Anthocharidi*), this pattern must have been gained at a remote epoch by the common ancestors of all so marked; whence it follows that this form of mimicry is of high antiquity and has been a supple means in the hands of nature of originating new forms. But on the other hand, parastatic mimicry, except in a few tropical cases like the *Leptalids*, must be of comparatively recent origin and cannot have been of any special service in the origination of new types. For not only do we often find it confined to a single sex of a species, but the species concerned sometimes departs so widely from the pattern of its fellows as altogether to set at defiance the laws of colorational pattern which otherwise hold good everywhere. If parastatic mimicry had obtained in the distant past and had been the means of originating new forms, it would have revolutionized the world of butterflies and have rendered far more complicated than now the explanation of their colorational patterns. We are, perhaps, eye-witnesses of the initiation of a new departure in the selective work of nature; a departure which the geologically speaking recent development of insectivorous birds has rendered necessary to the preservation of butterfly life.

Table of the species of Limochores, based on the egg.

Cells of the reticulation in the middle of the egg relatively large, averaging .04 mm. in diameter.....	manataaqua.
Cells of the reticulation in the middle of the egg relatively small, averaging .03 mm. in diameter.....	taumas.
Other species unknown.	

Table of species, based on the caterpillar at birth.

Ranged bristles relatively long, nearly one-seventh as long as the width of the head.....	manataaqua.
Ranged bristles relatively short, hardly one-eleventh as long as the width of the head.....	taumas.
Other species unknown.	

Table of species, based on the mature caterpillar.

Body dingy brown without longitudinal markings on the sides; papillae black with a smoky annulus at base.....	manataaqua.
Body dull olivaceo-griseous with a dusky infrastigmatal line and faint lateral band; papillae brownish fuscous with a pale annulus at base.....	taumas.
Other species unknown.	

No material exists for a table based on the chrysalis.

Table of species, based on the imago.

Under surface of the hind wings uniform tawny except for the paler rays formed by the nervures.....	bimacula.
Under surface of the hind wings brown, with a more or less distinct, extra-mesial, arcuate row of spots, the nervures concolorous.	
Spots of extra-mesial row on under side of hind wings often nearly obsolete; when present, faint, small, uniform and nearly obsolete, never reappearing on upper surface; discal stigma of fore wings of male not much, if any, broader than the antennal club, rarely followed below by fulvous; upper organ of male abdominal appendages surpassing the clasp.	
Extra-mesial series of spots on under surface of hind wings almost always tolerably distinct; fulvous markings of upper surface of fore wings of males usually not conspicuous above the discal stigma; the latter slender, elongate and almost perfectly straight; apical spine of lower half of split apex of male clasp distinct and prominent.....	manataaqua.
Extra-mesial series of spots on under surface of hind wings almost always obsolescent, sometimes scarcely perceptible; fulvous markings of upper surface of fore wings of males usually conspicuous above the discal stigma; the latter rather stout, short and distinctly sinuous; apical spine of lower half of split apex of male clasp sub-obsolete.....	taumas.
Spots of extra-mesial row on under side of hind wings generally distinct, always pretty large, not uniform, those beyond the cell being strigate, usually reappearing on upper surface; discal stigma of fore wings of male two or three times as broad as the antennal club, usually followed below by fulvous; upper organ of male abdominal appendages distinctly shorter than the clasp.....	pontiac.

LIMOCHORES BIMACULA.—The bright rayed skipper.

[Two spotted skipper (Maynard).]

Hesperia bimacula Grote-Rob., Ann. lye. nat. hist. N. Y., viii: 433-434 (1867).*Pamphila bimacula* Kirby, Syn. cat. Lep., 603 (1871);—Fern., Butt. Me., 103 (1884);—French, Butt. east. U. S., 334-335 (1886);—Mayn., Butt. N. Engl., 63, pl. 8, figs. 100, 100 a, b (1886).*Limochores bimacula* Seudd., Syst. rev. Am. butt., 59 (1872);—Min., Can. ent., iv: 150 (1872).*Hesperia acanootus* Seudd., Proc. Bost. soc. nat. hist., xi: 381-382 (1868).*Isoetion acanootus* Hew., Cat. coll. diurn. Lep., 229 (1879).*Hesperia illinois* Dodge, Can. ent., iv: 217-218 (1872); v: 60 (1873).

Figured also by Glover, Ill. N. A. Lep., pl. G, fig. 3, ined.

His choicefull sense with every change doth flit;
No common things may please a wavering wit.SPENSER.—*Melicopotos*.Into the sunshine
Full of light
Leaping and flitting
From morn till night.

RUSSELL.

Imago (10:20, 24). Head covered above with saffron tawny and blackish hairs, the latter mostly confined to a narrow, obscurely limited belt, crossing the head behind the antennae; tuft on either side of the antennae mostly composed of black bristles; the scales beneath and behind the eye are whitish, tinged with yellow as they approach the summit. Palpi white at base, gradually becoming yellowish and at summit deepening into tawny, on the apical half flecked with black scales, and along the outer, anterior edge of the middle joint with a row of black bristles; last joint blackish, flecked beneath with tawny. Antennae dark brown above, deepening into purplish on the club, faintly flecked throughout, and especially at the base of the joints, with dull luteous; beneath very pale, glistening tawny, more or less flecked with brown on the apices of the joints interiorly, the middle of the club more or less blackish; apical fourth of the club beneath and the crook naked and, excepting the apical dusky joint, dull orange.

Thorax covered above with saffron tawny hairs, mingled, especially on sides of patagia, with blackish ones; beneath with pale grayish hairs, sometimes tinged with yellow; femora blackish brown, overlaid on the outside and above with silvery scales, often flecked above with tawny; tibiae pale silvery yellow, heavily flecked on the inside with blackish brown; leaf-like appendage of fore tibiae yellowish brown; tarsi yellowish brown, deepening a little toward the tip, on the inside inclined to silvery; spurs pale silvery brown, tipped minutely with luteous; spines reddish luteous; claws the same; pad dusky.

Wings above rich dark brown, occasionally with a very slight, purplish tinge. Fore wings with an extra-mesial series of spots, the subcostal ones yellow or pale yellowish, very vague and subobsolete, especially in the ♀, situated below a point a little beyond the middle of the outer half of the wing; the median ones either two in number, not very large, tawny yellow in the median interspaces, situated in a line connecting the apex of the wing with the middle of the basal two-thirds of the inner border, and occasionally accompanied by a slight marking in the same line upon the submedian interspace (♀); or, larger, forming an equal and rather broad, tawny band from the upper median nervule to the submedian nervule, cut by dusky nervules, bounded within by the discal stigma and nearly an interspace in width (♂); the basal half or two-thirds of the wing is lightly flecked with tawny scales, but in the ♂ the portion lying between the subcostal and submedian nervules is also wholly dull tawny, infuscated a little next the nervules. Discal stigma rather slender, composed of two equal, similar, elongate ovate, very nearly continuous, blackish brown patches, extending from the

last divarication of the median to the middle of the basal two-thirds of the submedian nervure, parallel to each other, the inner slightly the lower and each scarcely four times as long as broad; they are unaccompanied by any inferior field of raised scales. The outer margin of the wing is edged with blackish, and the fringe pale brownish yellow, paler outwardly, and on the lower half almost or quite whitish. *Hind wings* without markings, the disc frequently tinged to a greater or less extent by long and delicate, tawny or olivaceous-tawny hairs; edge of outer margin scarcely darker than the wing; fringe dull whitish, infuscated next the base, and sometimes tinged slightly with yellowish.

Beneath: *Fore wings* pale saffron tawny, the mesal spots of the upper surface repeated beneath, that in the lower median interspace bordered on either side with grimy blackish; a similar infuscation fills the whole of the wing below the lower median nervule, excepting next the outer border and where it becomes pale by the extra-mesal spot; outer margin edged with a blackish line; fringe as above, infuscated at base, and tinged a little with yellowish on upper half. *Hind wings* uniform pale saffron tawny, excepting that the nervures are all very delicately but distinctly traced with pale scales, and that a narrow belt of grimy flecking follows below the submedian; a slender blackish line marks the outer border; the fringe is whitish, infuscated at base, along the inner margin wholly pure white.

Abdomen blackish brown, covered at base with olivaceous-tawny hairs, and flecked on the side with tawny, scale-like hairs; beneath almost wholly covered with dirty yellowish white scales. Male appendages (37:29) with the upper organ very slender, but no longer than the clasp, the hooks separate almost throughout, but together scarcely three times as long as broad, not tapering but narrowed on the apical half, each being formed of a cylindrical basal half and a smaller cylindrical apical half, straight, horizontal and parallel; lateral arms forming a depressed, laminate shield, equal, rounded at the tip and considerably longer than the hook. Clasp twice as long as broad, the basal half equal, with a sinuous upper margin; the apical half having a large, elevated, triangular, slightly incurved expansion at its base, its anterior edge abrupt, its upper edge a little recurved and coarsely subdentate; the apex of the clasp turns upward to a broad, triangular, upturned and slightly incurved, finely pointed expansion.

Measurements in millimetres.	MALES			FEMALES		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	15.	16.	16.75	15.5	16.5	17.5
antennae.....	7.45	7.75		6.5	7.5	7.4
hind tibiae and tarsi...	8.	8.25		7.25	8.2	8.55
fore tibiae and tarsi...	5.1	5.5		4.25	4.6	5.45

Described from 4 ♂, 6 ♀.

This butterfly may be distinguished from its near ally, *L. manatanqua*, by the bright rays of the under surface of the hind wings, and, at least in the male, by its considerably longer and slenderer antennal crook.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wings; the scales contained in it consist of jointed threads with long joints (51:2 b), consisting of seven or eight joints only, and no longer than the spatulate rods, sometimes with the apical margin entire and rounded (2 c), sometimes bilobed (2 a), which occur in the heart of the stigma; at the extreme base of the stigma is found a patch of rather short and stout two-pronged scales (2 d, f), while at the lower edge of the stigma are found many oblancoolate scales (2 e); the coverscales are large, apically expanded, the truncate apical margin irregularly and rather deeply undulate (2 g).

Distribution (32:1). This member of the Alleghanian fauna is little known but has been found over a tolerably wide range longitudinally. It is reported from Albany Co., N. Y. (Lintner), Ohio and Indiana

(Streeker), northern Illinois (Worthington, Douglass, Morrison), Iowa and Arkansas (Streeker), Nebraska (Edwards) and New Mexico (Snow).

The only New England localities yet reported are in Maine, Orono (Fernald), in New Hampshire, Milford, rare (Whitney), in Massachusetts, Mt. Tom and Springfield (Dimmock, Morrison), about Boston at Malden and Wollaston (Sprague), Lexington (Sanborn), Quincy (Merrill) and Walpole (Guild) and in Rhode Island (Seudder).

Life history. It appears to be but single brooded; probably the chrysalis hibernates. The earliest butterflies are seen about the middle of June, but some probably continue to emerge from the chrysalis for at least three weeks and they fly through July and into August.

The butterflies may be found in wet meadows but seem to be everywhere rare.

Desiderata. Not only are we entirely ignorant of the early stages of this butterfly, but the dates of its apparition are so meagrely reported that the above account is very insufficient. The flight and postures of the butterfly should be described and search made for parasites of the insect.

LIST OF ILLUSTRATIONS.—LIMOCHORES BIMACULA.

- | | |
|---|---|
| <i>Imago.</i> | Pl. 51, fig. 2. Scales of the discal stigma of fore wing of male. |
| Pl. 10, fig. 20. Female, upper surface. | <i>General.</i> |
| 24. Male, both surfaces. | Pl. 32, fig. 1. Distribution in North America. |
| 37:20. Male abdominal appendages. | |

LIMOCHORES MANATAAQUA.—The cross line skipper.

[Yellow-spotted brown skipper (Maynard).]

Hesperia manataaqua Seudd., Proc. Ess. inst., iii: 175-176 (1863).

Pamphila manataaqua Kirb. Syn. catal. Lep., 309 (1871);—French, Rep. Ins. Ill., ix: 160-161 (1878); Butt. east. U. S., 323-324 (1886);—Fern., Butt. Me., 102 (1884);—Mayn., Butt. N. Engl., 63, pl. 8, figs. 101, 101 a, b (1886).

Limochores manataaqua Seudd., Syst. rev. Am. butt., 50 (1872).

Isoteia manataaqua Hew., Cat. coll. diurn. Lep., 229 (1879).

Hesperia ceres Harr., Ins. inj. Veg., 3d ed., 316 (1862).

Talides vestris Boisd., Butl., Entom. monthl. mag., vii: 63 (1870).*

[Not *Hesperia ceres* Boisd.-LeC.; nor *Hesperia vestris* Boisd.]

Bright, airy, light and beauteous thing,
How transient here's thy stay;—
Then spread thy noiseless silken wing,
And flutter whilst thou may.
Now glancing oft from flower to flower,
Now basking in the sun,
Stealing fresh sweets from bush and flower,
Thus is thy labour done.

Thy tiny form, fit emblem seems
Of thy life's little day;
Thy colours bright, my fancy deems
Thy moments bright as they.
Thou art but as a meteor beam,
Lighting yon arch on high;
A sunbeam dancing on a stream,
A rainbow in the sky,—
Which live all gloriously awhile,
Then fade in air to die.

OSCAR.—To a Butterfly.

Imago (10: 23, 28). Head covered above with dingy greenish tawny hairs, brighter and less greenish away from the middle, in the ♀ with a transverse belt of reddish brown between and a little behind the antennae; the tuft on either side of the antennae

*The British Museum specimens examined by me in 1872 were not perfect enough to say certainly that they do not belong to *L. bimacula*.

black; the line of scales above and behind the eyes of an orange tint, becoming paler below and beneath whitish, tinged with yellowish. Palpi whitish below, tinged with yellowish, deepening in color apically where it is mostly orange or tawny, above and along the outer anterior edge of the middle joint mingled with black hairs; apical joint blackish brown, more or less flecked with yellowish in front. Antennae above posteriorly blackish brown, tinged with yellowish toward the base; beneath silvery pale straw yellow, the apices of the joints, especially anteriorly, marked with black; the club with a patch of orange, widening from the base on the anterior surface only; the apical fourth of the club, excepting the black portion and the whole of the crook, naked and excepting the apical dusky joint orange. Tongue black, the apical third tinged with castaneous, especially down the middle.

Thorax covered above with brownish green or olivaceous hairs, mingled in front with many blackish ones, where also they sometimes have a tawny tinge. Beneath with greenish gray hairs tinged with yellow. Legs dull buff, the tarsi slightly infuscated; leaf-like appendage of fore tibiae dull castaneous; spurs dull buff, dusky tipped; spines luteo-castaneous; claws the same, tinged with reddish; pad dusky.

Wings above rich dark brown, darker and with a slight maroon tinge in the ♀. *Fore wings* with a transverse series of pale yellowish, sometimes whitish spots in the middle of the outer half of the wing, consisting first of three subcostal, closely approximated, very small, longitudinal dashes depending from the middle of the outer two-fifths of the costal border; and second of two larger spots, the upper subtriangular, the lower subquadrato, in the median interspaces, in a line running from the apex of the wing to the middle of the inner margin; the lower of these spots is diminished in size in the ♂ by the discal stigma; there is often a small and obscure spot in the same row upon the submedian nerve. In the ♀ the wing is inconspicuously flecked with a few pale tawny scales near the base, along the inner margin and sometimes along the costal border, but in the ♂ the whole upper half of the wing, above the median nerve and the discal stigma, as far as the tip of the cell, and toward the costal border a little further, occasionally including the subcostal extra-mesal spots, is pale dull tawny, obscured by dusky scales along the subcostal nervules and the base of the subcostal nerve; the lower half of the wing as far as the discal stigma, and below it to the middle of the outer half of the wing, is also flecked with dull tawny but as a general thing very inconspicuously. Discal stigma (43:3) exceedingly slender and nearly straight, composed of two nearly continuous, equal, straight streaks, the inner removed below the outer by its own width and inclined in the least possible degree, its inner extremity being removed slightly downward; the outer crosses the lower median interspace, its pointed tip scarcely reaching the last divarication of the median nerve; the inner crosses the medio-submedian interspace, its inner extremity reaching the middle of the basal four-fifths of the submedian nerve; the stigma is nearly black and is followed toward the outer border, throughout its whole extent, by a patch of scarcely raised, soft, brown scales, deepening in color toward the stigma; the patch is irregular in shape, being narrow in the median and lower half of the medio-submedian interspace, but in the upper half of the latter fully twice as broad. Fringe nearly of the color of the wing, often slightly paler exteriorly and especially on the lower half of the wing. *Hind wings* with the disc slightly suffused, especially in the ♂, with a dingy tawny tinge, occasionally accompanied, especially where the tawny tinge is deepest, by a transverse, arcuate series in the middle of the outer half of the wing of very small and obscure, roundish, yellowish spots in the median, subcosto-median and subcostal interspaces. Fringe as on the fore wings, sometimes slightly tinged with yellowish.

Beneath, dark brown, but paler than above; *fore wings* with the same markings as are found above, the ♀ with the costal border flecked lightly with luteo-tawny scales and so resembling the ♂ more than above; outer margin delicately edged with a black line; fringe concolorous with wing. *Hind wings* uniformly flecked throughout, more or less heavily, but seldom very heavily, with luteo-tawny scales, giving a snuff-colored appearance to the wing; inner border sometimes paler; the spots of the upper

surface are seldom absent, but scarcely more distinct than above; edge of outer border and fringe as in fore wings.

Abdomen blackish above, yellowish tawny on the sides, blending into pale, dirty yellow beneath, flecked with blackish. Male appendages (37:28) with the upper organ not greatly longer than the clasps, the hooks as in mystic, but slightly separated at their tips and with a rounded slope to the sides before the middle; lateral arms as in mystic. Clasps twice as long as broad, much slenderer on the distal than on the basal half, the upward apical extension separated from the upper posterior lobe by a distinct sulcation; it tapers regularly and slenderly and, besides the pointed apical spine, is denticulated slightly on the edge next the spine; the upper lobe has a similar though heavier appearance on a side view, but its upper edge is pretty broadly incurved and bears several pretty large inturned denticulations.

Measurements in millimetres. Length of tongue, 15 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	18.5	14.5	15.	14.5	15.5	18.25
antennae.....	5.9	7.25	6.75	6.2	6.5	7.5
hind tibiae and tarsi.....	7.25	8.	8.5	7.8		8.75
fore tibiae and tarsi.....	4.8	5.25	6.25	5.	5.25	5.25

Described from 15 ♂, 16 ♀.

This butterfly is readily distinguished from *L. bimacula*, which it closely resembles in general appearance and in size, by the shorter and stouter apical portion of the antennal club of the male and by the absence of the paler scales upon the nervures of the hind wings beneath, which lend a peculiar appearance to the latter species. The snuff-colored tint of the under surface of the hind wings is a characteristic peculiarity.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wings: the scales in it consist of thread-like scales in the heart of the stigma (50:5 f), the joints tapering slightly and rather abruptly at either extremity, besides some slender androconia with rounded apex, about twice as large in the apical as in the basal half, being thus subspatulate; above the apical dash the cover scales, if they may so be called, are two-pronged and three-pronged slender scales (5 g, h), enlarged gradually from base to apex; so, too, at the base of the stigma the usual two-pronged rods become bidentate, moderately broad scales (5 b), only four or five times longer than broad, of large size; while in the field below the stigma the scales are either long, triangular, with rounded apex, either entire (5 e) or bilobed (5 a); or they are rounded, tridentate, equal, long and slender scales (5 c) with converging waved reflections.

Egg (66:26). Large, hemispherical, very pale green, flattened over a considerable space above, about a third broader than high; surface densely and most delicately punctured, excepting in the smooth, glistening, scarcely raised reticulation which covers the whole egg and forms a network of polygonal cells, mostly broader than high at the base, subcircular in the middle and higher than broad above, the average diameter being about .04 mm., and the punctuations in each cell from 12 to 20 in number, very uniformly distributed and uniform in size and shallowness. Above, the cells diminish rapidly in size in a space about .2 mm. in diameter to form the micropyle rosette (69:14), in which the cell walls are extremely faint and delicate. Height, .8 mm.; diameter, 1.1 mm.

Caterpillar. First stage (73:3). Head (80:63) and all its appendages brownish piceous, with a few, very fine scattered hairs, the surface very sparsely and shallowly punctate and slightly and faintly corrugate. Triangle of head transversely rugose, with the suture above it transversely punctate; labrum with a reddish tinge. Body pallid green with the dorsum of the first segment covered with a piceous shield

composed of a broader, anterior, elevated, convex collar and a posterior, slenderer, flat field, both extending to a minute, triangular, piceous piece just above the fuscous spiracle. Front pair of legs piceous; other legs and prolegs green with the claws of former a little dusky. Appendages (86:52) pellucid, about one-third as long as the segments. Long, recurved, sweeping hairs on last segment. Length, 3.25 mm.; breadth of head, .68 mm.; length of bristles, .60 mm.

Second stage. Head (80:64) piceous, minutely rugose with very short and excessively fine scattered hairs. Body equal, pallid green, the hinder segments embrowned, with a faint, narrow, dusky, dorsal stripe and a pallid substigmatal band at edge of substigmatal fold; whole upper surface profusely dotted with brown warts, emitting each an extremely short, tapering, black hair; some specimens are more heavily flecked than others. Thoracic shield piceous, smooth, separated considerably from the triangular, suprastigmatal patch, the portion of the segment in front of it milk white; a few long, curving, black hairs on the last segment which is very broadly rounded behind; spiracles piceous, those of the first thoracic and eighth abdominal segments forming a crateriform tubercle; legs and prolegs of the color of the under surface which is pallid, the claws of legs fuscous and the whole front of the first pair of legs blackish fuscous annulated with white at the incisures. Length, 7.5 mm.; width of head, .8 mm.; of middle of body, 1.2 mm.

Third stage. Does not differ from the previous stage except in a slightly more pronounced rugosity to the head, in a little darker tone to the body, owing to the greater size and depth of color of the brown warts sprinkled everywhere. Width of head, 1.2 mm.

Fourth stage. Head black, densely but rather delicately rugose with numerous fine and very short tawny hairs; eye specks and antennae piceous; labrum castaneous edged with pallid. Body parallel sided, broadest rather behind the middle, the first thoracic segment pallid with a piceous shield, with scattered, short hairs arising from minute and low, piceous warts; rest of body dingy, almost fuliginous brown in general effect, arising from multitudinous, minute, black warts with a smoky surrounding on a dirty, pallid base. The last segment is, however, lighter, and there is a slender, dusky, dorsal line on the other abdominal segments due to the extension here of the fuliginous surrounding of the black warts; from these last arise excessively short, pale hairs. Lips of spiracles pallid with a narrow, black areola, the large ones infuscated centrally. Legs piceous, the last pair only at tip, the rest luteo-fuscous. Prolegs like the body. Length, 10 mm.; breadth of head, 1.6 mm.; of body, 1.6 mm.

Distribution (32:2). This butterfly is a characteristic member of the Alleghanian fauna. The points from which it has been reported outside of New England, although distant from each other, are but few in number: Canada West (Brit. Mus.), Illinois (Worthington), Fort Niobrara, Nebraska (Carpenter), Iowa (Austin), Maryland (Harris), Albany and Bethlehem, N. Y. (Lintner). Geddes even states that he found it, but very rare, at Fort MacLeod, southern Alberta, which is a long way from any known neighbors. Aaron even thinks *Hesperia baracoa* Luc. of Cuba and southern Florida the same species, which is hardly probable from what we so far know of its distribution.

In New England it has also been found in distant stations. The northernmost are Brunswick (Packard) and Portland, Me. (Lyman), and next to them Walpole, N. H. (Smith). It has been several times taken in the neighborhood of Boston (Merrill, Faxon, Guild, Sanborn, Scudder) and in the Connecticut valley at Springfield (Emery), Deerfield, Mt. Tom

(Sprague), and Granby, Mass. (Sprague, Seudder). It has also been found in Rhode Island and in Connecticut—Farmington (Norton), Oxford Hayes, Mus. Yale Coll.) and Guilford (Smythe).

Life history. The butterfly appears to be single brooded and probably passes the winter as a chrysalis. It makes its appearance in the imago state the very last of June, occasionally as early as the 22d; by the 7th of July it becomes abundant, and remains on the wing not only through July, but in diminished numbers far into August. Mr. Lintner even took a specimen as late as the 9th of September. The eggs are laid in July—all that I have had about Cambridge between the 14th and 17th—and hatch in about thirteen days. The caterpillars feed readily on ordinary grasses, and their tubular nests are rather loosely constructed of grass blades, in which, however, all the lateral slits are kept from opening by numerous connecting threads between the blades. It takes them about three weeks, sometimes a little more, to pass two moults, and it is not until late in September that they can reach the chrysalis, in which state they probably winter. Like the preceding species the butterfly is found in moist meadows.

Desiderata. Nothing whatever is known of the later preparatory stages of this insect, and until this lacuna is filled, our knowledge of the butterfly must be considered meagre. Whether it winters as a mature caterpillar or as a chrysalis is unknown. It should be sought for in all localities in which it has not been detected, in order to extend our knowledge of its distribution. Only an outline of the probable history of the butterfly is given above, and this needs the confirmation of repeated observation. The flight and postures of the butterfly and the habits of the caterpillar should be studied, and parasites sought. As it has been supposed by some to be identical with the next species, the question of its life history is the more important.

LIST OF ILLUSTRATIONS.—*LIMOCHORES MANATAAQUA*.

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|--|--|
| <i>General.</i> | |
| Pl. 32, fig. 2. Distribution in North America. | Pl. 86, fig. 52. Dermal appendage of the caterpillar at birth. |
| <i>Egg.</i> | |
| Pl. 66, fig. 26. Outline. | Pl. 10, fig. 23. Female, upper surface. |
| 69: 14. Micropyle. | 28. Male, both surfaces. |
| <i>Caterpillar.</i> | |
| Pl. 73, fig. 3. Caterpillar at birth. | 37: 28. Male abdominal appendages. |
| 80: 63, 64. Front views of head, stages I, II, | 43: 3. Discal stigma of fore wing of male. |
| | 50: 5. Scales of the discal stigma. |

LIMOCHORES TAUMAS.—The tawny-edged skipper.

[The tawny-edged skipper (Gosse); clear-winged skipper (Maynard).]

- Papilio taumas* Fabr., Mant. Ins., ii: 84 (1787).
Pamphila taumas Butl., Cat. Fabr. Lep., 277, pl. 2, fig. 14 (1809).
Limnarches taumas Seudd., Syst. rev. Am. butt., 50 (1872); Butl., 306, figs. 113, 169 (1881).
Hesperia taumas Fabr., Ent. syst., iii: 327 (1793);—God., Encycl. méth., ix: 723, 766-767 (1819).
Hesperia phocion Fabr., Ent. syst. suppl., 431 (1798).
Pamphila phocion Butl., Cat. Fabr. Lep., 277, pl. 3, fig. 9 (1809).
Hesperia themistocles God., Encycl. méth., ix: 723, 760 (1819).
Hesperia ceres Boisdu-Lec., Lép. Amér. sept., pl. 76, figs. 1-2 (1833);—Edw., Morr. Syn. Lep. N. A., 351 (1862).
Pamphila ceres Westw.-Hew., Gen. diurn. Lep., ii: 323 (1832);—D'Urb., Can. nat., v: 246 (1860);—French, Rep. Ins. Ill., vii: 160 (1878);
 Butt. ent. U. S., 320-321 (1880);—Fern., Butt. Mo., 101-102 (1884);—Mayn., Butt. N. Engl., 61, pl. 6, figs. 102, 102, 102 a (1886);—Fletcher, Rep. ent. soc. Ont., xix: 87-88 (1880).
Hesperia arogos Boisdu-Lec., Lép. Amér. sept., pl. 76, figs. 3-5 (1833).
Pamphila arogos Morr., Syn. Lep. N. A., 118 (1862).
Hesperia ahaton Harr., Ins. Inj. Veg., 3d ed., 317, fig. 140 (1862);—Morr., Syn. Lep. N. Amer., 111 (1862).
Isolemon ahaton Hew., Cat. coll. diurn. Lep., 228 (1879).
Pamphila ahaton H. Edw., Stand. nat. hist., ii: 471, fig. 602 (1884).
Pamphila origenes Morr., Syn. Lep. N. A., 117 (1862).
 Figured also by Glover, Ill. N. A. Lep., pl. 23, figs. 6, 9; pl. 84, fig. 5; pl. F, fig. 20; pl. T, fig. 6, lined.
 [Not *Hesperia origenes* Fabr.]

The butterfly wavers dreamily near.

STORY.—*In the Garden.*

All wanton as a child, skipping and vain.

SHAKESPEARE.—*Love's Labour's Lost.*

Imago (10: 17, 21; 13: 16). Head covered above with pale, yellowish green hairs, mingled with black ones, lying beneath which are blackish scales; eye encircled, excepting in front, with a narrow band of pale yellowish scales, above more or less tinged with fulvous; tuft on either side of the antennae composed of black bristles, with a few yellow ones next the antennae; palpi whitish or dirty white toward base, faintly tinged with yellowish, which becomes a little deeper toward the apex; the apical half sprinkled in front with black, hair-like scales, a little longer than the others, and along the outer under edge of the middle joint is a sparse series of long black bristles; apex viewed from above more distinctly yellowish, with abundant black hair-like scales; apical joint blackish, flecked in front with yellowish, especially on its basal half. Antennae black above, beneath pale silvery buff, becoming suffused with tawny on the anterior surface of the club, the apices of the joints marked vaguely with blackish, especially toward the front; apical third of the club beneath and all of the crook naked and excepting the dusky apical joint deep castaneous. Tongue black, toward tip tinged with castaneous.

Thorax covered above with greenish fulvous hairs having a grayish tint or in the female inclining to brown, mingled, especially in front, with many blackish hairs; beneath with pale greenish gray hairs, having a tinge of yellowish particularly in front. Legs grayish brown tinged with olivaceous, especially on the femora, the final joints of the tarsi becoming dusky; leaf-like appendage of the fore tibiae dull brown; spurs brownish tipped minutely with blackish; spines dull luteous; claws dusky reddish; pad dusky.

Wings above dark brown, occasionally with a slight, warm, ferruginous glow, especially on the hind wings, where it is caused by long, tawny hairs. Fore wings of ♀ with an extra-mesial series of small, yellowish fulvous spots, three longitudinal and equal, ranged at right angles to the costal border at a very little beyond the middle of its outer half, two larger, quadrate, the lower the larger, and placed nearer the base,

In the median interspaces, the interior margin of the lower at a distance from the outer margin of the wing equal to that of the last divarication of the median nervule; there is also often a smaller, faint spot in continuation of the last mentioned, in the lower half of the medio-submedian interspace; the costal margin is longitudinally dashed, a little distance from the edge, sometimes in the upper part of the outer half of the cell, with obscure tawny, which in a single specimen under examination mimics the ♂ in extending as a large, tawny patch, from the middle of the cell to the costal edge and from the base of the wings to the extra-mesial spots. In the ♂ the medio-submedian spot and usually also the lower median spot are wholly wanting, while the others or at least the subcostal ones are rendered inconspicuous by being wholly or partially submerged in the large, broad, tawny patch upon the costal border, which almost invariably extends from the lower limit of the cell to the very edge (which itself is blackish) and in the least favored individuals is confined to the region above the outer half of the cell; usually it extends to the base or close to the base of the wing and, as stated, to the extra-mesial, subcostal spots; but often it extends over the outer limits of the discal stigma to embrace also the median spot or spots; and sometimes the lower half of the wing is also largely powdered with tawny scales as far as the middle of its outer half. The discal stigma (43: 7) is comparatively rather broad, sinuous, extending from just beyond the last divarication of the median to the middle or just before the middle of the submedian nervule; it is about five times as long as broad, rounded at either extremity and broadest in the middle; its outer inferior edge is slightly concave as far as the middle of the medio-submedian interspace, when it turns rather abruptly toward the base; the middle of the inner half of the upper edge is notched; the stigma consists of a slender, tapering streak of velvety black occupying the whole of the outer apex, following the upper border as far as the notch; an oval patch of the same beyond the notch and a very slender, velvety, black edging to the under border; these enclose an elongated, lunoid, dull black patch; the stigma is followed outwardly by a rounded patch of slightly raised, iridescent, dark brown scales, seated upon all but the outer and inner fifth of its outer inferior border, about half as deep as broad, and equally disposed on either side of the lower median nervule. In both sexes the outer margin has an inconspicuous, black edging and the fringe is pale, occasionally tinged with yellowish, its basal half infuscated. *Hind wings* without markings except as before mentioned and a blackish edging to the outer border as in the fore wings. Fringe as in fore wings.

Beneath generally rather dark brown, but sometimes gray brown, always flecked, especially on hind wings, with scales of a brighter color in greater or less profusion.* These scales also vary from very pale greenish gray, through rather pale greenish yellow, the more common to saffron tawny, giving various shades to the wing, according to their frequency, or if infrequent, to the ground color of the wing; the more general effect is a dull dark olivaceous. *Fore wings* with the markings of the upper surface repeated, the tawny much paler and the extra-mesial spots, the lower median ones of which occur more frequently in the ♂, generally whitish; the outer border is narrowly edged with a blackish line, and the fringe resembles that of the upper surface, except in wanting the dusker base. *Hind wings* uniform and immaculate excepting that the brighter scales usually cluster into minute, exceedingly inconspicuous, sometimes paler spots in a transverse series, extending from the upper subcostal to the upper median nervules, a little before the middle of the outer half of the wing; outer border usually most delicately edged with a blackish line; fringe resembling that on the fore wings.

Abdomen above blackish brown, covered next the base with olivaceous hairs on the sides, the tips of the joints, especially the apical ones, covered with fulvous hair-like scales; beneath pale greenish gray. Male abdominal appendages (37: 16) with the

*They are entirely wanting, however, to the rich dark brown under surface of the wings of specimens from Cape Breton (Thaxter),

Nova Scotia (Jones) and Nepigon (Fletcher), specimens which are also exceedingly small.

upper organ not greatly longer than the clasps, the hooks nearly four times as long as broad, a little excised on the basal half, afterward tapering on the next quarter only, beyond which the tips are slender, nearly attinent and horizontal, and rather bluntly terminated; lateral arms free, as far as the hooks are from each other, as long as they, aculiform. Clasps rather more than twice as long as broad, more nearly sabre-shaped than in the other species, the upper margin being convex beyond the basal excision, the upper angle terminating in a short, aculiform spine, not curved inward, and nearly concealed by the upper posterior lobe which is directed backward, nearly horizontal, triangular and more than twice as long as the spine.

Measurements in millimetres. Length of tongue, 10 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	10.45	13.5	15.75	12.5	14.	15.5
antennae.....	5.2	6.5		5.6	6.35	6.6
hind tibiae and tarsi..	4.75	7.45		4.6		9.
fore tibiae and tarsi..	3.8	5.	5.4		4.0	5.5

Described from 62♂, 25♀.

Specimens from Cape Breton and Nova Scotia, as shown by Mr. Thaxter's collections and others sent by Mr. J. M. Jones, of Halifax, as well as those found at Nepigon and other boreal parts of Canada, are remarkable for their smaller size, and the almost total absence of dull fulvous dusting upon the under surface of the hind wings, the upper and under surface being almost precisely alike in general tint.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wings; the scales contained in it consist of the usual jointed, thread-like hairs in the heart of the stigma, the joints relatively short (49:4 f); besides these are other scales of a peculiar character (4 b, e), consisting of a stem tapering at either extremity and having a broad, spatulate apex, sometimes connected with the stem by an excessively slender thread, sometimes with a scarcely perceptible stragulation (these are wrongly marked on the explanation of the plate as found in the field below the stigma; they occur there only by accident); just above the middle of the stigma are found exceedingly slender cover scales of various forms (4 c, g, h, i), and at the extreme base of the stigma the usual two-pronged rods (4 a), here rather slender.

Egg (66:29). Cells of an irregular, angular shape, .03 mm. in diameter; their surface covered with excessively minute, shallow, and rather broad punctuations; inner cells of micropyle six or eight in number, .0106 by .017 in size, five of which seem to be tipped by canals, surrounded by nearly uniform, somewhat angular oval cells, only a little larger than the central ones and scarcely increasing in size outwardly, the largest being but .0127 by .021 mm. in size. Color pale green. Height, .6 mm.; width, .84 mm.; width of flattened portion of summit, .34 mm.; diameter of micropyle, .153 mm.

Caterpillar. First stage. Head black, shining, smooth or minutely wrinkled with distant shallow punctures, .01 mm. in diameter, each giving rise to a delicate white hair .06 mm. long; antennae black, the last joint small and short, fuscous, giving rise to a pair of colorless short hairs; mouth parts black. Body white, transversely wrinkled; there is a faint dorsal line; a subdorsal row of straight fuscous bristles (86:53), clubbed and pellucid at tip, placed on the middle of the anterior half of each segment from the second thoracic to the penultimate abdominal, and directed upward and inward, .05 mm. long; also a lateral row of similar appendages, not inclined, on the posterior half of the same segments; just above and beneath the stigmata there is a similar row on the anterior half of the segments, and the infrastigmatal series with another on the posterior half of the segments; first thoracic segment with a black dorsal shield bearing a transverse row of six long, straight, spinous hairs, not tapering, the tip white, at least .09 mm. long; stigmata dark fuscous; the last segment bears in the middle of either side a long recurved hair and a pair of similar ones on the hinder edge, closely approximate; besides there are on either side at the edge three long ones slightly recurved; second and third thoracic segments each with a lateral, double, rounded, pale, corneous spot on either side .015 mm. in width; first pair of legs black, others pellucid, last joint and claw in-

fuscated. Length of body, 1.8 mm.; width, .4 mm.; of head, .56 mm.; length of long hairs, .32 mm.

Second stage (80: 60). Mr. Fletcher tells me that the body is yellowish, the last abdominal segment darker from the reddish brown pile.

Third stage. Head (80: 61) black with short, inconspicuous, whitish hairs; first thoracic segment almost covered by an unbroken, equal, dorsal shield from just above the spiracles on one side to the same point on the other. Body pale brownish yellow with a dull greenish tinge above, and an exceedingly faint, dusky, laterostigmatal line; whole body heavily and uniformly flecked with blackish brown dots, formed of the little warts. Length, 4 mm.; breadth of head and body, .85 mm.

Fourth stage (77: 27). Head (80: 62) black, minutely and uniformly but irregularly punctate, covered with very short, delicate, pale brown hairs; mouth parts and antennae all black. Body dull olivaceo-griseous, darker above than below, flecked all over with minute, brownish fuscous dots in a pale annulus, each emitting a hair like those on the head; an indistinct, slender, dusky, medio-dorsal line and on the abdominal segments a similar infrastigmatal line; first thoracic segment pallid with a pretty broad, equal, picous shield reaching from just above the spiracle to the same point on the other side; prolegs concolorous with body; legs blackish fuscous; spiracles black; the last segment of the body broadly bordered with a fuscous band and provided also with a similar medio-dorsal stripe; a scarcely discernible, dusky, lateral band. Length (in early part of stage) 8 mm.; breadth, 1.5 mm.

Last stage (77: 35). Head black, coarsely punctured and pubescent. Body rich purplish brown with a green tinge, showing through the transparent skin; thoracic shield black and shining, the rest of the first thoracic segment milk white above; surface of body finely mottled with gray and dark purplish brown, and, like the head and thoracic shield, covered with a fine, short, black pubescence; contractions of dorsal vessel plainly visible, giving the appearance of a dark brown dorsal stripe, ending posteriorly in a blackish triangle, on each side of which are two small, laterodorsal, black, comma-like dashes, running backward half way to the exterior margin of the anal plate which is black above, whitish beneath. Thoracic legs and spiracles black, the posterior pair, with the markings on the anal plate, giving the appearance of a bear's face. Length, 25 mm. (After Fletcher.)

Chrysalis (85: 44). Head and prothorax black, together with the legs and antennae; wings at first green, afterwards greenish black; meso- and metathorax brown, the former edged posteriorly with blackish fuscous; the abdomen light brown with slight and minute infuscations; the whole body with sparsely scattered, ferruginous papillae, annulate at base with black or fuscous, supporting moderately long, tapering, pointed, straight or arcuate, pallid hairs which are more or less tufted at the extreme front and on either side of the ocellar ribbon, those at the front of the body more or less fulvous, those upon the abdominal segments longer, as long as the segments, sub-recumbent, directed backward; cremaster luteo-testaceous, edged with fusco-castaneous; hooklets castaneous. Surface everywhere very delicately vermiculate. Length of body, 13 mm.; of cremaster, 1.3 mm.; width of head, 3.25 mm.; of mesothorax, 3.85 mm.; of abdomen at third abdominal segment, 4.35 mm. From a specimen sent by Mr. Fletcher, aided by his notes.

Distribution (32: 3). This butterfly is found over perhaps a larger extent of territory than any other species of the tribe. A member principally of the Alleghanian fauna, it appears also to occur in nearly the whole of both the Canadian fauna to the north and the Carolinian to the south. Excepting specimens brought from Florida by Mr. Maynard, the southernmost examples have occurred in the west at Dallas, Texas (Boll), and in the east in Virginia (Coll. Amer. ent. soc.), Delaware (the same), and Louisville, Ky. (Belknap, Mus. Yale Coll.). To the west it occurs abund-

antly, not only as far as Wisconsin (Hoy), Iowa (Allen, Osborn, Parker, Austin), Nebraska (Dodge) and eastern Kansas (Snow), but also to the Rocky Mountains across our border, from which region it was brought home by Macoun and Geddes, and in our own territory is known from Dakota and Montana (Morrison), Colorado (Mead) and New Mexico (Snow); Boll also reports it from Dallas, Texas. Northward it occurs throughout the inhabited parts of Canada and beyond, from Quebec "rare" (Bowles, Fyles), Cape Breton (Thaxter) and Nova Scotia (Jones), to Nepigon (Fletcher, Scudder), Crow's Nest, lat. 50° , long. 115° , and Calgary (Geddes) and Sounding Lake, lat. 52° N., 110° 30' W. (Fletcher).*

In New England, as might be expected, it is everywhere common, from the White Mountains, and even from the highest peaks of the same, to the southern and eastern sea coast.

Oviposition. Eggs are laid freely in confinement on ordinary grass, attached lightly to either side of the blades. I first received them from Messrs. F. A. Clapp and J. B. Hambly, and they hatched in from 11 to 14 days in the middle of June. One obtained at Nepigon, Lake Superior, and carried to Ottawa, took fifteen days or more to hatch.

Habits of caterpillar. The larva feeds upon common grasses, and seems to feed only by day. "All grasses offered," says Fletcher, "were eaten readily, *Panicum crus-galli* and *Triticum repens* perhaps with the greatest avidity, and *Phleum pratense* with the least." It is an indolent and yet timorous creature; it requires a great deal of time to escape from the egg, often twenty-four hours; it appears to feed only by day, and retires at the least alarm, curling up if disturbed when out of its nest, but rarely leaving it, living always close to it and eating the driest blades rather than go to the least distance for fresher material; it is a most passive creature; one reared by Mr. Fletcher spun in its last stage, but six weeks before pupation, and long before it stopped eating, a light but close web, like the small cocoon of a *Catocala*.

Mr. James Fletcher gives the following as his experience in raising the caterpillar:—

As there was only one of these young larvae, I kept it in a glass tube for better examination, and it turned out to be a very interesting captive. Instead of making a tent by catching the opposite edges of leaves together, it spun a nest against the side of the bottle and would extend itself from the nest and eat its food. After third moult, it was removed to a tin-topped jelly glass. Here, too, it spun a cocoon-like nest from which it reached forth and ate its food. On September 8th it appeared sluggish, and I thought it was going to pupate. It was almost an inch long, and I knew must be full grown, so it was placed in a tuft of grass, where it very soon spun a cocoon amongst the leaves close to the root and remained in a semi-torpid condition, sometimes coming out on warm days and eating a little. On 13th October I found that it had pupated, and I was thus in possession of the complete life history of the species. The chrysalis, which was contained in a light cocoon about an inch long, made by catching a

*The extreme northwestern extension of the color on the map was given for this instance, when I understood (wrongly) that the longitude was 121° W.

few blades of grass together and lining them with silk, was almost erect and seemed to be kept from lying against the cocoon by a few strands of silk. (Rep. ent. soc. Ont., xix: 87-88).

Life history. The butterfly is double brooded in the central part of its range, single brooded in the northern, and in both passes the winter as a chrysalis. The first generation makes its appearance in Massachusetts during the last week in May, usually between the 20th and 25th. In a week it becomes abundant, and by the middle of June most specimens are badly rubbed; a week later it begins to diminish rapidly, and yet a few specimens may often be found throughout July. Early in June the females begin to lay their eggs, and continue to lay them until the middle of July. The second brood of butterflies, which is generally less abundant than the first, appears near the end of the first week in August, sometimes during the last week of July, becomes abundant in about a week, lays its eggs at least from the middle of the month onward, and continues on the wing until the latter part of September; the caterpillars from these eggs probably change to chrysalis before hibernation. It is quite improbable, however, that larvae from eggs of the first brood laid as late as the middle of July, mature rapidly enough to reach chrysalis in time for it to disclose the butterfly the same season, and this will account for the scarcity of the second brood, which is found as far north as Ottawa. In northern places with late springs, like Nova Scotia and Nepigon, the insect is certainly single brooded; eggs laid by fresh butterflies early in July, probably never mature so as to reach chrysalis until late in the season. The instance mentioned above, due to Mr. Fletcher's care, is the only one known to me in which the insect has been carried from egg to chrysalis; in this case the eggs carried to Ottawa hatched in thirteen days, the first moult was passed eight days thereafter, and the caterpillar lived for only a week less than three months, changing to chrysalis the middle of October; all the later moults were passed in the month of August.

Habits of the butterfly. The butterflies frequent open fields, meadows, roadsides, pathways and exposed sunny spots. They are fond of flowers and Guignard reports finding one entrapped in a *Cypripedium*. When feeding upon a flower the fore wings are usually raised so much as to be at right angles to each other, while the hind wings are horizontal. The antennae, viewed from the side, are straight and depressed at an angle of about 25° with the plane of the body; viewed from above they are curved a little, the convexities outward, and diverge broadly at an angle of about 140° , bringing the antennal tips 12 mm. apart; the crooks of the clubs are bent backward.

Parasites. The only known instance of a parasite disturbing a member of this tribe, though probably it is common enough, is in an egg parasite which I obtained from the egg of this species at Nepigon. It emerged

August 5 from an egg laid about July 7 and was determined by Mr. Howard as *Telenomus graptæ*. A single specimen only emerges from an egg.

Desiderata. The complete life history of this butterfly needs careful working out. The story as given here is dependent almost wholly upon observing the times of appearance and condition of butterflies throughout the season in many different places. Its apparition in fresh condition at two different periods of the year, at least in southern New England, is unquestionable, but the behavior of caterpillars obtained from the earliest and latest eggs of the first brood under perfectly natural conditions should be carefully observed and the dates of eclosion of the resulting butterflies compared with the occurrence of the butterfly out of doors, in order to determine to how great an extent the insect is single or double brooded in different places. So, too, the caterpillar hatched from eggs laid by butterflies of the second brood should be followed to see in what condition the progeny of this brood passes the winter. Much more might be written of the habits of both caterpillar and butterfly, and careful observation of the comparative histories of the butterflies of the far north, peculiar for their small size and dark appearance, with those further south should be made, in order to determine whether or not two species are here confounded. Is there any seasonal dimorphism in this insect?

LIST OF ILLUSTRATIONS.—LIMOCHORES TAUMAS.

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|---------------------|------------------------------------|------------------|---|
| <i>General.</i> | | <i>Imago.</i> | |
| Pl. 32, fig. 3. | Distribution in North America. | Pl. 10, fig. 17. | Male, both surfaces. |
| <i>Egg.</i> | | 21. | Female, upper surface. |
| Pl. 66, fig. 29. | Outline. | 13: 16. | Male, both surfaces in black. |
| <i>Caterpillar.</i> | | 13: 16. | Male abdominal appendages. |
| Pl. 77, fig. 27. | Caterpillar in fourth stage. | 42: 18. | Neuration. |
| 35. | Mature caterpillar. | 43: 7. | Discal stigma of fore wing of male. |
| 80: 60-62. | Front views of head, stages II-IV. | 49: 4. | Scales of the discal stigma. |
| 86: 53. | Dermal appendage, stage I. | 60: 5. | Side view of head and appendages enlarged, with details of the structure of the legs. |
| <i>Chrysalis.</i> | | | |
| Pl. 85, fig. 44. | Chrysalis. | | |

LIMOCHORES PONTIAC.—The black dash.

[Green margined skipper (Maynard).]

- Hesperia pontiac* Edw., Proc. ent. soc. Philad., II: 17-18 (1868); pl. 11, fig. 5 (1864).
Pamphila pontiac Klrh., Syn. cat. diurn. Lep., 600 (1871);—Edw., Cat. Lep. Amer., 52 (1877);—French, Butt. east. U. S., 335-337 (1886);—Mayn., Butt. N. Engl., 59, pl. 7, figs. 91, 91a, omitted from expl. pl. (1886).
Limochores pontiac Scudd., Can. ent., XIX: 45 (1887).
Hesperia conspiciua Edw., Proc. ent. soc. Philad., II: 17, pl. 5, fig. 5, 2 figs. (1868);—Park., Can. ent., III: 51-52 (1871).
Hedone orono Scudd., Syst. rev. Amer. butt., 58 (1872).
Isoleinon orono Hew., Cat. coll. diurn. Lep., 228 (1879).
 Figured also by Glover, Ill. N. A. Lep., pl. I, fig. 2, ined.
 [Not *Hesperia conspiciua* Scudd., 1868; nor *Atrytone conspiciua* Scudd., 1872.]

This said, he whisk'd his party-colour'd wings,
 And down to earth he comes, more swift than thought.

RALEIGH.—An Heroical Poem.

Imago (17:2, 5). Head covered profusely with saffron yellow hairs and scales, supplanted largely by brown hairs between and a little behind the antennae, and sprinkled sparsely throughout with shorter blackish hairs; the arching tuft of hairs outside of the antennae composed above of shorter yellow hairs, below of longer black hairs, the longest scarcely extending more than one-sixth way around the eye. Basal half of palpi pale, scarcely yellowish white, beyond deepening first into lemon, afterwards into saffron yellow, with a few intermingled black scales both above and below; terminal joint saffron below, blackish above. Antennae orange tawny, duller toward the base, paler beneath than above, interrupted distinctly at the tips of the joints with blackish patches, fading out on the club and which are wanting beneath posteriorly; above anteriorly they are often lengthened so as to reach the base of the joints; apical half of the club posteriorly purplish black, the crook dusky castaneous, often obscured with blackish toward the base, especially behind.

Thorax covered above on the anterior half with mingled tawny and greenish yellow hairs and scales, behind with grayish green, silky hairs; beneath with smoky brown scales covered and concealed by pale greenish yellow hairs with a few intermingled black hairs. Legs tawny buff, much paler interiorly, upon the outer side of the femora dark chocolate brown, and streaks or blotches of the same upon the upper surface of the tibiae, at the extreme base and often near the tip; the upper surface of the tarsi grows a little dusky toward the tip. Spurs clay yellow, naked and reddish brown at the tip; spines pale reddish luteous, deepening a little toward the tip of the tarsi; claws dark castaneous; paronychial fuliginous.

Wings above blackish, slightly glistening brown. Fore wings either flecked with a few dull tawny scales upon the basal fourth of the wing, often extending further outward along the costal and inner borders, but especially along the latter; and marked by a sinuous series of rather small, a little unequal, pale yellow spots slightly tinged with tawny, traversing the middle of the outer two-thirds of the wing subparallel to the outer border; the upper three are similar, the uppermost slenderest and occasionally absent, long and narrow, about as long as the breadth of the upper median interspace, diverging very slightly from each other like the rays of a fan and occupying the third, fourth and fifth superior subcostal interspaces, their interior extremities lying in a line nearly or quite at right angles to the costal border at the middle of its outer two-thirds or a little beyond that; the two interspaces below are occasionally immaculate, or, much smaller, irregular, squarish spots are found below the outer extremity of the upper spots, the lower the innermost; the median interspaces have larger spots in the same line with the two smaller ones, or nearly in a line from the apex of the wing to the middle of the inner border; their inner borders are

convex and their outer concave; they are as broad as the interspace and longer than broad; in the same line, but below the outer edge of the median spots, more illly defined, small, triangular spots occur in the upper and lower halves of the interspace below, the upper often obsolete and both more tinged with tawny than the other spots (♀); or, the basal two-thirds of the wing, marked by the same limitations as the outer edges of the spots in the female, is copper-tawny, excepting, of course, the sexual dash, and excepting also the nervures above the middle median nervule, the upper interspace beyond the cell, the costal edge, and occasionally also the whole costal border to the subcostal nervure, excepting the spots, which would then wholly correspond, save in depth of color, to the upper subcostal spots of the female; all these are of the color of the outer margin; but the upper interspace beyond the cell is sometimes flecked with tawny, especially outwardly and sometimes the upper half of the interspace below is also blackish; the extreme base of the wing is much begrimed with dusky scales so as to leave it but little tawnier than in the other sex; the sexual dash (43:10) is velvety black and consists of two oval patches, each a little more than twice as long as broad, almost in continuity, but the innermost slightly lower than the other, extending from the final divarication of the median nervure to the middle of the basal two-thirds of the submedian nervure (♂). Basal third of fringe blackish, beyond pale dusky, often tinged slightly with tawny. *Hind wings* of the same color as the fore wings, the lower half of the wing, excepting the basal third, covered with rather profuse greenish tawny hairs, a little duller in the female than in the male; either furnished with a transverse series of three or four pale tawny longitudinal dashes in the middle of the subcostal and median interspaces, those in the interspaces beyond the cell twice as long as the others and approximate, the outer limit of all forming a regular curving line subparallel to the outer border at a little beyond the middle of the outer two-thirds of the wing (♀); or, these same spots are present, but nearly or quite as bright tawny as the brighter parts of the fore wing, and blended into an area cut only by the dusky nervures, and those of the interspaces beyond the cell often completely united; sometimes, however, the wing is almost wholly immaculate (♂). Fringe, as in the fore wing, but more often tinged with tawny.

Beneath: *Fore wings* blackish fuliginous, the costal border and whole apex heavily flecked with cinnamoneous tawny, the patch extending down the outer border, narrowing as it goes, to the tip of the lower median nervule; the spots of the upper surface of the female are repeated in both sexes beneath, and the nervules in the outer third of the wing, especially below, are often flecked lightly with pale ochreous scales; in the male the reverse of the sexual dash is black, rather than fuliginous. Fringe blackish at the base, beyond dusky, but below the lowest median nervule pale, often tinged with tawny. *Hind wings* cinnamoneous tawny, more or less obscured by dusky, upon which the spots of the upper surface of the female appear in both sexes as dull tawny with obscure outlines; the united spots of the interspaces beyond the cell often extend vaguely toward the base and the medio-submedian interspace is often suffused from base to border with a similar, though not so distinct a tinge, making two broad rays of tawny along the wing; the veins are generally flecked with pale buff scales. Fringe blackish on the basal third, beyond obscure tawny, clearer next the inner margin.

Abdomen blackish brown above, overlaid at base by grayish green hairs; lower part of the sides tawny, merging into lemon yellow beneath. Appendages of the male (37:30) with the upper organ not so long as the clasp, the hook, as seen from above, equal throughout, the tips slender, cylindrical, separated by twice their own diameter, straight; lateral arms free only from the base of the separated tips of the hooks and then forming a common, depressed, straight or slightly twisted blade, extending beyond the hook and split down the middle. Clasps much more than twice as long as broad, of nearly equal width throughout, but with a deep pre-mesal oblique slit, just beyond which the upper edge is distinctly lobed and incurved; apex angulate but barely pointed above.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	14.75	15.4	17.5	15.75	17.2	18.2
antennae.....	6.75	7.	8.35	7.4	7.6	7.8
hind tibiae and tarsi....	7.75	8.1	9.4	8.	8.2	9.
fore tibiae and tarsi....	4.75	5.	6.35	5.2	5.35	5.5

Described from 10 ♂, 11 ♀.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wings; the scales contained in it consist of slender and equal jointed threads (50:4 b) in the heart of the stigma; at the extreme base of the stigma a collection of rods or narrow scales of two forms, some (4 a) long and slender with rounded apex, and tolerably broad throughout, narrowing very slightly toward the base, others much slenderer, more rod-like scales (4 b), abruptly truncate at tip, very slender and scarcely enlarged from base to apex; some exceedingly long and slender spatulate hairs are found, with long oval spatulae, some near the base of the stigma (4 c), others at the extreme tip (4 f); above the apical member of the stigma is found a cluster of two-pronged rods (4 g), while in the field below the stigma in the median interspace are some toothed scales (4 d, e), the teeth well rounded and irregular, the scales themselves of varying form but always broad.

Distribution (32:4). So far as yet known, this butterfly is confined to the Alleghanian fauna, but it has been found at widely separated localities; passing from west eastward these are: Nebraska (Edwards), Grinnell, Iowa (Parker), Wisconsin (Hoy), Lansing, Mich. (Edwards), Hudson City, N. J. (Lintner), and another locality, probably in New Jersey (Merrill). According to a determination of Strecker it has been taken in Montreal by Caulfield; and Strecker gives also Minnesota, Indiana and Ohio. I have specimens also from Illinois and from Brooklyn, N. Y.

In New England it has only been reported from the vicinity of Boston, where it has been taken in Cambridge and Jamaica Plain by Morrison, and in Malden and Wollaston by F. H. Sprague.

Life history. The only clue to the life history of this insect is furnished by the memoranda taken by Messrs. Morrison and Sprague of their captures about Boston. The butterfly has only been taken in July, at least as early as the 10th and as late as the 27th; one year, on the 10th, Mr. Sprague took twelve males and one female, all new; on the 12th he found the male very common and took three or four females, and both male and female were common and good on the 17th; specimens taken on the 27th were rubbed. In Iowa, Professor Parker found them in great abundance in 1884, whereas in former years they were very rare.

Desiderata. The poverty of the above account sufficiently shows that no facts, even the merest records of capture with sex and condition, can fail of adding to our knowledge of this modest looking butterfly; of the early stages we know nothing. Its western distribution is very likely much greater than indicated on the map.

LIST OF ILLUSTRATIONS.—*LIMOCHORES PONTIAC*.

- General.*
 Pl. 82, fig. 4. Distribution in North America.
Imago.
 Pl. 17, fig. 2. Female, half of upper surface.
- Pl. 17, fig. 5. Male, both surfaces.
 87: 80. Male abdominal appendages.
 43: 10. Discal stigma of fore wing of male.
 50: 4. Scales of the discal stigma.

EUPHYES SCUDDER.

- Euphyes* Scudd., Syst. rev. Amer. butt., 59 (1872).
 Hesperia pars Auctorum.
 Pamphila pars Auctorum.
Type.—*Hesperia metacomet* Harr.

Happy insect what can he
 In happiness compared to Thee?
 Fed with nourishment divine,
 The dewy morning's gentle wine!
 Nature waits upon thee still,
 And thy verdant cup does fill;
 'Tis filled wherever thou dost tread,
 Nature's self thy Ganymede.

ANACREON.—(Cowley's Translation.)

Imago (50:7). Head large, heavily clothed with pretty short hairs, arranged in large, transverse masses; just outside the antennae, a small, scarcely spreading, appressed bunch of arcuate bristles, passing about one-fifth way around the eyes. Front protuberant and tumid, wholly and especially just below the middle, but not greatly, surpassing the front of the eyes; from two and a half to three times as broad as long, the front border very broadly rounded, the middle half almost straight, delicately margined and in the middle slightly and roundly elevated, separated from the vertex by a slightly impressed, straight or scarcely curved line connecting the middle of the antennae. Vertex but slightly tumid, scarcely and about equally raised above the level of the eyes, transversely flat or very nearly so, longitudinally and regularly rounded, separated from the occiput, which is a little sulcate in the middle longitudinally, by a gently impressed, brace-shaped sulcation. Eyes large, pretty full, nearly circular, naked. Antennae inserted with the middle of their posterior half in the middle of the summit, separated from each other by nearly three times the diameter of their basal joints, the whole antenna as long as the abdomen (in the ♀ sometimes a little shorter than the abdomen), composed of from thirty-five to thirty-nine joints, of which from seventeen to twenty-one, usually nineteen, form the club, which is slightly more than half as long as the stalk; the crook excluded, about four times as long as broad, rather slender oval, increasing in size very gradually at the base, largest a little beyond the middle, tapering more rapidly and rounded off at the tip; the crook composed of from four to six joints in the ♀, of seven to eight in the ♂, always of two or three more in the ♂ than in the ♀, and correspondingly slenderer in the former; in both tapering regularly to a delicate point, in the ♂ about three times as long as broad, and fully as long as the breadth of the club; in the ♀ from two to two and a half times longer than broad, and scarcely as long as the breadth of the club; middle joints of the stalk three times as long as broad, the third from the base of antennae scarcely four times as long as broad. Palpi pretty stout, nearly one and a half times longer than the diameter of the eye, heavily clothed with a large mass of partially erect scales, beyond which fully half of the terminal joint, covered only with recumbent scales, projects; basal joint bullate, subpyriform, largest at the tip, as long as broad; middle joint large, bullate, obovate, largest at distal extremity, but almost equally rounded at either end, slightly arcuate, as broad as the basal joint and fully twice as long as broad; the apical joint seated on the middle of the tip of the second joint, straight, cylindrical or subconical, slender, from three to five times as long as broad, and slightly shorter than the breadth of the middle joint.

* *εὐφύης*, the comely one.

Prothoracic lobes rather small, appressed, laminate, subtriangular, the inner and lower sides nearly straight, the upper outer arcuate, less than half as long again as high and not so long as the shorter diameter of the eye. Patagia not very large, about four-fifths as long as the breadth of the head, the posterior lobe half as broad and not half as long again as the base, straight or slightly curved, nearly equal, broadly rounded at the tip, nearly four times as long as broad.

Fore wing (42:17) somewhat less than twice as long as broad, the lower outer angle falling distinctly outside the middle of the costal margin; the latter straight or scarcely convex; the outer margin gently and regularly convex, slightly bent in the middle in some instances; the inner margin scarcely concave. Costal nervure terminating at a little before the apical third of the costal margin; subcostal nervure moderately close to the costal margin, the second nervure arising a little before the middle of the wing; cell two-thirds as long as the wing, very slender, subequal in the apical two-thirds; first median nervure arising at a little more than half way from the base to the origin of the second branch, the latter a little below the base of the second subcostal nervure; internal nervure straight, short.

Hind wing somewhat longer than broad; the lower distinctly longer than the upper half in the male, equal in the female; the costal margin is straight beyond the strong basal lobe; the outer margin well rounded and full, with the sexual differences noted; anal angle well rounded; cell excessively short. The first median nervure originating at but a slight distance before the second and at about an equal distance further from the base than the subcostal fork.

Discal stigma of male closely resembling that of *Limochares*; the scales contained in the stigma consist of stiff jointed threads, two-pronged and single-pronged rods of varying thicknesses at the base of the stigma, and long and slender androconia of various forms, toward the apex of the stigma, generally larger at the apex than at the base, and always tolerably well rounded at this point, but sometimes equal throughout.

Legs 2, 3, 1. Femora clothed beneath with a rather thick fringe of hairs, on all but the fore legs decreasing greatly in length from the base toward the tip; hind tibiae furnished above with a very thin fringe of long hairs. Femora 2, 1, 3; tibiae 2, 3, 1; tarsi 3, 2, 1. Fore and hind femora fully two-thirds the length of the middle femora; fore tibiae two-thirds the length of the fore femora, half the length of the middle and hind femora. Leaf-like appendage of the fore tibiae long and slender, tapering on the outer half to a point and at the same time curved; attached to the middle of the outer four-fifths of the joint, it surpasses its tip and is fully five times as long as broad; other tibiae armed at tip with a pair of very long and slender unequal spurs, the hind tibiae with a secondary exactly similar pair in the middle of the outer two-thirds of the joint; both middle and hind tibiae with lateral rows of distant, rather long spines. Tarsal joints 1, 2, 3, 4, 5 except on fore legs where they are 1, 2, 3, 5, 4, the terminal scarcely longer than the antepenultimate joint; fore tarsi as long as the middle femora, two-thirds as long as the hind tarsi which are scarcely longer than the middle tarsi; all furnished with a triple row of very delicate spines, the apical ones of each joint but little longer than the others; basal joint as long as the others combined, excepting in the middle and hind legs of *E. verna*, where it is equal only to the second, third and fourth combined; second about half as long as the basal joint. Claws small, compressed, tapering, strongly arcuate, especially near the middle; pad pretty large; paronychial bifid, the upper lobe compressed, laminate, slightly falcate, reaching the tip of the claw and considerably longer than broad; the lower slender, thread-like, half as long as the claw.

Abdominal appendages: Upper organ not very large, very slender, abruptly arched, the hook connate at base, the extremities widely separated and therefore as a whole not tapering, upcurved a little at the tip; lateral arms forming an inferior, straight and horizontal lamina, sometimes bifid, well separated from the hook. Clasps very large and broad, pretty strongly convex, as long as the upper organ, the apical portion with an extensive posterior extension as well as an upper triangular lamina.

Mature caterpillar. Head smaller than any of the body segments excepting the

first and last. Body plump, smooth, scarcely at all moniliform, largest in the middle, tapering forward on the very extensible thoracic segments, and backward from the middle of the sixth abdominal segment; terminal segment considerably depressed, well rounded, its edge furnished with a single close fringe of short hairs; all the segments full beneath, so as to present little difference between those furnished and those not furnished with prolegs. First thoracic segment with a very narrow dorsal shield in the middle, no broader than the legs, continuous, tapering below and not attaining the spiracles. Body covered profusely with minute, short, tapering hairs arising from minute wartlets. Spiracles small, with a raised rim, obovate, twice as broad as long. Prolegs exceedingly short. Legs short, equal. Body highest at about the fifth abdominal segment, pretty well arched, of equal width when contracted excepting the first thoracic and last abdominal segment.

This genus, moderately rich in species, is peculiar to North America and extends across the continent south of Lat. 45° as far as Cuba, where one species occurs. Two are found in New England, both only in the southern portion.

The butterflies are of small size and the males provided with a linear discal streak on the fore wings. They are dark brown, generally almost wholly devoid of markings, but sometimes with a few pale or semi-vitreous spots across the middle of the fore wings and an obscure, transverse, pale streak on the under surface of the fore wings.

Very little is known of their history or of their early stages. They are single brooded, flying in July. The caterpillars much resemble those of *Atrytone*, but are livelier in color with a slender black thoracic shield, set off by the pallid front of the first thoracic segment.

EXCURSUS LXXIII.—HOW BUTTERFLIES SUCK.

"Schmetterling
Kleines Ding
Sage, wovon lebst Du,
Dass Du nur in Lüften schwebst?"
"Blumenduft, Sonnenschein,
Das sind die Nahrung mein."

Der Knabe wollte ihn fangen,
Da bat er mit Zittern und Bangen:
"Lieber Knabe, thu' es nicht,
Lass mich spielen im Sonnenlicht.
Ei! vergeht das Morgenroth,
Liege ich doch schon kalt und todt."

HEY.—*Knabe und Schmetterling.*

In the caterpillar we find on either side, besides the biting jaws, a pair of appendages of simple structure called the maxillae; they are seated on a common hemispherical prominence and look like supplementary antennae, these latter organs having in the caterpillar much the same structure; the joints of the maxillae possess only the power of withdrawal and protrusion; the outer and larger appendage consists of several joints; the inner of only a single joint, which becomes enormously developed in the butterfly to form a sucking organ of curious construction; while the outer

appendage becomes the maxillary palpus, reduced to a couple of minute joints or even less, only to be detected by the most careful observer, and physiologically null.

As this sucking mouth is one of the most characteristic parts of the perfect butterfly, we will examine it more closely. Although almost entirely concealed when coiled, it is frequently as long as the entire body, and consists of two lateral halves united down the middle; each half is composed of an immense number of short, transverse rings, which are convex on the outer surface, concave on the inner (87:23); and it is by the union of these inner concavities that a central tube is formed. The lateral rings are also partially hollow, and have, therefore, been supposed by some to form the sucking tube, in which case the insect might be said to have two mouths, for there would be two entrances to the oesophagus. This, however, is not the case, the interior of each lateral half being occupied by muscles, tracheae, and nerves for the movement of the organ. The rings of which it is composed are made up of a great number of plates, united by the more yielding part of the cuticle, allowing of great freedom of motion. These rings throw off, at the points where the convex and concave sides meet, a series of oblique, curving plates or hooks, which, when the two maxillae are brought together, interlace in the most complete manner, to form a perfectly flexible yet impervious tube. The outer walls of the lateral tubes are supplied with curious papillae of great varying shapes, size, and abundance in different groups, but, in general, more highly organized and abundant in the highest family. These must probably be regarded as organs of taste. Within either half of the maxillae, oblique muscles exist (87:9), serving to coil the whole into the watch-spring-like form in which it is packed away when at rest.

But now that we comprehend the structure of this wonderful piece of mechanism, and can appreciate the change that has been wrought in its development from an utterly simple, almost microscopic joint, do we understand any better its actual use in extracting honey from flowers? Some have thought that the upward flow was due to capillary motion; some to the action of the so-called sucking stomach, a sac-like expansion of the alimentary canal just in advance of the true stomach; others that it is forced on by successive undulations and contractions of the tube itself. The investigations, however, of one of our own naturalists (who has more recently distinguished himself in the construction of the swiftest yachts in the world) has lately shown the existence of a muscular sac within the head (87:5) at the origin of the alimentary tract, furnished with a valve at its front extremity where it opens into the maxillary canal. When the radiating muscles running from the walls of the head to the periphery of this sac are contracted (87:3), the sac is opened, and into the vacuum thus produced the fluids into which the maxillae tips are plunged ascend. On

the relaxation of these muscles and the squeezing of the sac by the muscles which encircle it, the fluids, prevented by the valve from retreating the way they came, are forced down the alimentary canal.

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Table of the species of *Euphyes*, based on the imago.

Upper surface of wings almost completely uniform, devoid of markings except for the black discal stigma of the male and a pale point or two beyond the centre of the fore wing sometimes found in the female; extremity of upper organ of male abdominal appendages broadly cleft on upper aspect to more than its width, the cleft U-shaped; tip of clasp produced to a sharp angulation.....*metacomet*.
 Upper surface of wings with a transverse series of conspicuous vitreous markings in both sexes; extremity of upper organ of male abdominal appendages broadly cleft on upper aspect at about half its width, the cleft V-shaped; tip of clasp well rounded.....*vera*.

EUPHYES METACOMET.—The dun skipper.

[Immaculate skipper (Scudder).]

- Hesperia metacomet* Harr., *Ins. Inj. veg.*, 3d ed., 317 (1862);—Morr., *Syn. Lep. N. Amer.*, 111 (1862).
Pamphila metacomet Kirb., *Syn. catal. Lep.*, 600 (1871);—French, *Rep. Ins. Ill.*, vii: 161 (1878); Butt., *east. U. S.*, 326-327 (1880);—Fern., *Butt. Me.*, 102-103 (1884);—Mayn., *Butt. N. Engl.*, 64, pl. 8, figs. 103, 103 a, b (1886).
Pamphila rurea Edw., *Proc. nat. sc.*, 1862, 58 (1862).
Hesperia rurea Edw., *Trans. Amer. entom. soc.*, i: 288 (1867).
Hesperia kiowa Reak., *Proc. entom. soc. Philad.*, vi: 150 (1866).
Pamphila kiowa Streck., *Cat. Amer. Macrolep.*, 171 (1878).
Euphyes metacomet Scudd., *Syst. rev. Am. butt.*, 59 (1872); Butt., *figs.* 76, 189 (1881).
Hesperia vestris Boisdl., *Ann. soc. ent. Fr.*, (2) x: 317-318 (1852);—Morr., *Syn. Lep. N. Amer.*, 109 (1862).
 Figured also by Glover, *Ill. N. A. Lep.*, pl. 23, figs. 4, 5, ined.

Through the valley, through the valley, where the glittering harebells peep,
 Where children come to laugh away their happy summer hours,
 To chase the downy butterfly, or crown themselves with flowers.

ELIZA COOK.—*Through the Waters.*

Imago (10: 29, 30). Head covered above with rather pale but dull olivaceous hairs, mingled especially in the ♀ with some black ones, the tuft on either side of the antennae black; hairs and scales encircling all the eye, but the front pale yellow below, bright yellow above. Palpi pale yellow, almost white at base, beyond deepening into lemon yellow, while above, at tip, it is of the color of the upper surface of the head, sparsely flecked throughout with black scales and provided rather abundantly along the outer and especially the inner edge of the outer surface with black hairs, which also are found abundantly above; inner surface dark fuliginous; terminal joint blackish brown, in front excepting at tip olivaceous. Antennae above blackish, beneath rather pale orange, interrupted at the tip of the joints, especially in front, with blackish, the apex of the club beneath and the whole of the crook naked and dark castaneous, the last joint dusky. Tongue castaneous, slightly lighter apically.

Thorax covered above with brownish olivaceous tawny hairs, on the prothorax more like the upper surface of the head, with many intermingled black scales; beneath with pale lemon-gray hairs. Femora dark slate brown, the upper and outer surface flecked or wholly covered with silvery gray; tibiae pale slate brown externally, within dusky at base, beyond pale yellowish; leaf-like appendage of fore tibiae pale, glistening, yellowish brown; tarsi pale, glistening buff; spurs the same, tipped with blackish red; spines and claws reddish luteous. Pad blackish.

Wings above rich dark brown, the fore wings occasionally tinged slightly, especially toward the base and along the costal border, with ferrugineo-tawny or luteo-tawny and the hind wings often furnished, especially on the lower half of the disc, with dull, dark, olivaceous-tawny hairs. Both wings with a faint darker line at the outer margin. *Fore wings* of ♂ with no other markings excepting the discal stigma (43:13) which is inconspicuous, nearly straight, composed of two nearly equal, ovate, black edged, blackish brown patches, rounded basally, pointed apically, the outer slightly above the inner, scarcely larger and parallel to it, about four times as long as broad; its apex scarcely reaches the last divarication of the median, while the base of the inner is followed above by a minute patch of velvety black compact hairs, touching the submedian nervure a little beyond the middle of its basal two-thirds; the stigma is followed in the lower median and medio-submedian interspaces by a very inconspicuous area of slightly raised brownish scales usually tinged with tawny, rather wider than the stigma, divided into two confluent patches by the lower median nervule, each extending furthest toward the border at its upper outer limit on the nervule above it. *Fore wing* of ♀ with three subcostal, cloudy whitish spots often obsolete or obsolescent, seldom distinct enough to be longitudinal, arranged at right angles to the costal margin scarcely beyond the middle of its outer half; and two larger, though small and usually distinct, white, median spots, the upper round, or when larger subtriangular, close to the base of the upper median interspace, the lower usually transversely crescentic, sometimes transverse and straight in the lower median interspace, below a point midway between the upper spot and the last divarication of the median nervure; the two spots fall in a line drawn from the apex of the wing to the middle of the inner border; in rare instances, there is a faint, pale, cloudy streak on the submedian nervure below the lower spot; and the outer edges of the subcostal and median spots are then united by an equally indistinct, arcuate series of cloudy spots, its convexity outward. Fringe of both wings scarcely paler than the ground color of the wing, growing paler outwardly.

Beneath dark brown, not so rich as above, the apex of the *fore wings* and the whole of the hind wings tinged slightly with olivaceous (♂) or purplish (♀). *Fore wings* in the male slightly paler in the median interspaces just beyond the reverse of the discal stigma; in the female the markings of the upper surface are repeated. Fringe much as above. *Hind wings* with an extra-mesal, arcuate, obscure, very narrow, pale band, parallel to the outer border, in the middle or shortly before the middle of the outer two-thirds of the wing from the upper subcostal to the submedian nervure; it is composed of broken spots, often nearly imperceptible in the ♂, never distinctly defined, even in the ♀. Fringe as above.

Abdomen blackish brown, covered above at base with dark olivaceous hairs, on the sides with very dull, olivaceous-tawny scales, beneath grayish with mingled whitish and dusky scales. Male appendages (37:23) having the upper organ with the centrum pretty strongly arched on the horizontal portion, the hook three times longer than broad, similar in form and relation to those of *L. blunacina*; lateral arms forming a single equal lamina, connate throughout, rounded at the tip, appressed to the hooks, somewhat longer than they and slightly upturned at the apex. Claspers scarcely more than twice as long as broad, the upper margin with a rounded basal lobe, but scarcely any sign of an apical one excepting a transverse incision before the middle of the clasp; apex produced posteriorly as a sabre-like expansion, finely angled, but not drawn to a point; and superiorly as a large, broad, rounded, incurved lobe, directed slightly forward.

Measurements in millimetres. Length of tongue, 12 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	14.	14.5	15.5	13.5	14.5	14.75
antennae.....	6.75	7.4	7.4	6.	6.25	6.5
hind tibiae and tarsi..	7.	8.	8.6	6.5	7.47	7.35
fore tibiae and tarsi..	4.5	4.85	5.	4.	4.5	4.75

Described from 52 ♂, 56 ♀.

The female of this species, which much resembles that of several of our Pamphilidi besides its congener, may be distinguished from most of them by the purplish tinge of the under surface of the hind wings; from *Thymelicus aetna*, with which it agrees in this respect, by the lesser breadth of the vague extra-mesal pale band on the same surface; and from its congener, by the spot in the lower median interspace of the fore wing which is here much less conspicuous.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wing; the scales contained in it consist of jointed threads (51: 4 d) in the heart of the stigma, and at the base of the stigma are found not only some very stout, two-pronged rods (4 c) but also some exceedingly slender awl-shaped rods (4 b), enlarging very slightly and gradually at the apex. In the vitreous spot of the lower interspace of the female are found some quadrate scales with rounded sides, rather broader than long, the entire margin finely striate and with wavy reflections (4 a).

Egg (66: 32). Entire surface covered with a fine tracery of exceedingly delicate, raised lines, forming polygonal cells which are higher than broad above, the reverse and subquadrate below, and on lower half of sides forming wavy pseudoribs by being subcontinuous; interspaces punctate, most profusely on lower half.

I am not quite sure that this figure and brief description belong to this species.

Distribution (31: 7). This Alleghanian species has a wide distribution, especially in the west, extending from the Atlantic seaboard to the Rocky Mountains, where it was found long ago by Reakirt in Colorado, has since been found in the same state by Putnam, Snow and Packard, and comes from as far south as New Mexico (Snow) and as far north as Montana and Dakota (Morrison). Its western distribution, however, is uncertain, for, occurring as it does upon the Pacific coast itself in northern California and southern Oregon (A. Agassiz), it must be found in the intervening region from which it has never been obtained. East of the Rocky Mountains it occurs as far north as Dakota, Iowa, where it is a common species (Allen and others), Wisconsin (Hoy), southern Michigan, common (Harrington), Nepigon, north of Lake Superior (Fletcher), London, rare (Saunders), and Sudbury, Ont. (Fletcher), Ottawa, rare (Billings, Fletcher) and Montreal, not common (Caulfield). On the south it extends as far as Virginia (Mus. Amer. Ent. Soc.) and West Virginia (the same) in the east, and Dallas, Texas (Boll) and New Mexico (Snow) in the west.

In New England it is widely spread, although it has been taken but rarely in the northern half,—at Norway (Smith), Hallowell (Miss Wadsworth) and Portland, Me., common (Lyman), and Thornton, N. H. (Thaxter). Still it is not uncommon at Walpole (Smith) Milford (Whitney), and even at Plymouth, N. H. (Scudder), in Massachusetts is found

even in such elevated places as Amherst (Parker), and Mount Tom (Dimmock), and south of lat. 43° is found everywhere, always rather common and sometimes, as in Nantucket, abundant.

Life history. The butterfly is single brooded, but the stage in which it hibernates is uncertain. It generally appears on the wing during the very last days of June, occasionally as early as the 22d, becomes abundant in early July, is generally rubbed—at least this is true of the male—by the middle of July, and continues in scanty numbers until the middle, occasionally as late as the third week of August. In the northern part of its New England range, however, fresh specimens of both sexes are often taken at the middle of July; and Lyman says it is found at Portland, Me., at the end of August.

The butterfly frequents fields and other open ground, where its fondness for flowers renders it an easy prey to the collector. It is particularly attracted by the flowers of mint, fireweed and Indian hemp.

Desiderata. Our entire ignorance of the early stages of this trim little butterfly renders the above account of its history exceedingly meagre. Unfortunately it can not even be relieved by an account of the flight and attitudes of the butterfly nor by any sketch of its parasites. If the Californian vestris is the same as this, we are very ignorant of its distribution, or how and where the intervening space between it and the eastern type is bridged over.

LIST OF ILLUSTRATIONS.—EUPHYES METACOMET.

<i>General.</i>		Pl. 37, fig. 23. Male abdominal appendages.
Pl. 31, fig. 7. Distribution in North America.		42: 17. Neuration.
<i>Egg.</i>		43: 13. Discal stigma of fore wing of male.
Pl. 66, fig. 32. Outline.		51: 4. Scales of the discal stigma.
<i>Imago.</i>		60: 7. Side view of head and appendages
Pl. 10, fig. 29. Female, both surfaces.		enlarged, with details of the structure of
30. Male, upper surface.		the legs.

EUPHYES VERNA.—The little glass-wing.

[Spotted brown skipper (Maynard).]

<i>Pamphila verna</i> Edw., Proc. acad. nat. sc., Philad., 1862, 57 (1862);—French, Butt. east. U. S., 324-325 (1886);—Mayn., Butt. N. Engl., 64-65, pl. 8, figs. 104, 104 a (1886).	<i>Hesperia verna</i> Wold., Proc. entom. soc. Philad., 11: 540, 541 (1864). <i>Euphyes verna</i> Scudd., Syst. rev. Am. butt., 69 (1872).
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It grieves the bee and butterfly
Because they strive in vain,
To hoard the scent of flowers,
Whose honeyed cups they drain.

STODDARD.—Chinese Songs.

Imago (10: 27, 33). Head covered above with hairs of varying shades of greenish yellow, largely mixed with black ones; below with whitish scales, tinged faintly with yellow and with a few slender, blackish hairs; the scales extend behind the eye, becoming yellowish above and over the eye greenish yellow; tuft on either side of the

antennae black. Palpi dull whitish at base, becoming tinged more and more with yellowish toward the tip, especially on the outside, and on the upper half of the front largely supplanted away from the edges by blotches (♂) or flecks (♀) of blackish fuliginous scales; down the outer and inner edges of the outer side a series of long, blackish bristles, increasing in abundance toward the tip; viewed from above, the palpi are clothed as the upper surface of the head; terminal joint blackish brown. Antennae very dark purplish brown above, at the base of the club more or less flecked with yellowish scales; beneath nacreous, shading into pale orange toward the brown and where meeting it in front the joints are orange at their base and blackish at their tips; the apical three-fifths of the under surface of the club is blackish; the crook is brownish yellow, darker toward the club, paler apically.

Thorax covered above with brownish olivaceous hairs and dark brown scales, the prothorax similar to the upper surface of the head but of a deeper yellow and with many black scales in the middle; beneath, the thorax is covered with pale, dirty yellow hairs, sometimes tinged with greenish dusky; femora maroon brown in a median band on the inner side, elsewhere pale orange; tibiae yellow flecked with brown above and on the inside; leaf-like appendage of fore tibiae pale, glistening, brownish yellow; tarsi brownish yellow, marked rather heavily with brownish above, especially toward the apices of the joints; spurs yellowish, tipped with luteous or reddish luteous; spines reddish luteous; claws slightly darker; pad dusky.

Wings above rich dark brown; inner margin of the *fore wings* rather scantily provided with dull olivaceous hairs; at right angles to the costal margin, scarcely beyond the middle of its outer half, a subcostal series of three dull whitish spots, sometimes scarcely tinged with yellowish, each about half as long again as broad; besides these, there is a small, triangular spot at the base of the upper median interspace and in the lower median interspace a pretty large, square (♀), or oblique, transverse, rhomboidal (♂) spot a little within the upper median one; there is rarely a minute spot at the lower edge of the subcosto-median interspace, on a line with the median spots and not infrequently a more yellowish, often faint, small, triangular one in the same line on the submedian nervure, its apex toward the base of the wing; there is also often a small, round spot (♀), or longitudinal dash (♂) at the lower edge of the cell a little within the last divarication of the median nervure. Discal stigma of male (43:17) formed of an inconspicuous, exceedingly slender, scarcely bent or arcuate, blackish streak, extending from the last divarication of the median to the middle of the basal four-fifths of the submedian nervure; it is but twice the breadth of the antennal stalk but appears wider from being accompanied on either side by a narrow, blackish cloud. Outer margin edged with blackish brown. Fringe considerably paler than the ground color, infuscated next the base. *Hind wings* rather abundantly provided with dull olivaceous hairs, especially below the middle of the cell, but not reaching the outer border; some paler yellowish, obscure flecks are occasionally seen in an arcuate series in the middle of the outer two-thirds of the wing, between the upper subcostal and middle median nervules, at least in the ♀. Outer margin and fringe as in the fore wings.

Beneath dark brown, the upper half of the fore wings and the whole of the hind wings tinged with ruddy purplish. *Fore wings* with the markings of the upper surface repeated, and below the lower median spot more or less flushed with pale; outer margin edged narrowly with blackish. Fringe much as above but tinged slightly with the hue of the under surface. *Hind wings* with an extra-mesial, bent series of small, dull, pale yellowish spots, rather distinct in the ♀, scarcely perceptible in the ♂, extending from the middle of the costo-subcostal to the medio-submedian interspace, the innermost spot just below the middle of the lowest median nervule; the series is bent at the lower subcostal nervule and the spots increase in size away from it; a small, faint, pale spot sometimes occurs near the tip of the cell of the ♀. Outer border edged narrowly with blackish; fringe as above.

Abdomen dark brown, sides covered with olivaceous hairs; beneath pale yellow, interrupted with dusky at the base of the joints. Upper organ of male appendages

(37: 35) much broader than in metacomet, with the centrum gently arched in its horizontal portion, the hook scarcely more than twice as long as broad, the triangular depressed tips separated from each other by a V-shaped excision extending less than one-third the length of the hook, the extremities blunt. Lateral arms connate only at their base, beyond equal, lying beneath and widely separated from the hooks, as long as they and parallel to them. Clasps about two and one-half times longer than broad, nearly equal but a little broader at the apex than at base, the apex produced posteriorly as a very large, well rounded lobe as broad as the clasp and superiorly as a broad, triangular, pointed expansion, a little incurved at the tip, overlaid by the long and narrow, equal, bluntly pointed, upward and a little backward but not inward directed expansion two or three times as long as broad.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	14.25	15.	15.75	14.5	15.5	17.
antennae.....	7.3	7.5	8.	7.35	7.5	8.
hind tibiae and tarsi..	7.5	7.8	8.25	7.25	7.5	8.
fore tibiae and tarsi..	4.75	5.	5.	4.75	4.7	5.5

Described from 7 ♂, 8 ♀.

The unusually large size of the spot in the lower median interspace of the fore wing readily separates the female of this species, not only from its congener but from several other species which it otherwise much resembles.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wing; the scales contained in it consist of jointed threads (50: 6 f) in the heart of the stigma; of stout, two-pronged rods of considerable breadth (6 a) at the extreme base of the stigma; and at its extreme tip a great variety of androconia with rounded tips sometimes wavy and of very varying widths, often largest at the apex and narrowing gradually toward the base, and at other times equal throughout the greater portion of their extent; these varieties are shown in figures 6 c, g, h, i, k, l; the cover scales (6 e) are twice as long as broad, enlarged gradually from base to apex and have a wavy, slightly convex outer margin. In the vitreous spot in the lower median interspace of the male are found very finely striate scales (6 b), nearly quadrate but rounded on all sides and nearly equal throughout; while similar scales (6 d) in the same spot of the female are vaguely tridentate at the tip and more rounded at the base, but otherwise they do not differ.

Egg (66: 35). As represented in the drawing by Mrs. Peart, the egg is very pale green, almost white, very regularly and uniformly domed, not very much more than half as high as broad; but the sketch is such that it probably gives, even in outline, an apparently less height than it really has.

Caterpillar. Last stage (77: 25, 26). Head (80: 65) dull castaneous, edged behind with black, the minute points with which it is covered a little darker and the hairs pale brown; labrum very dark green, jaws blackish, antennae pale castaneous, ocelli black.

Body yellowish or wood brown with a russet tinge along the upper half, flecked rather uniformly and profusely with minute, dark brown spots, and covered by pale brown, short hairs, arising from black dots; a slender, medio-dorsal stripe of blue black, deepest at the front of each segment, similar slender, dusky, supralateral and infralateral stripes, fading away at either extremity beyond the third thoracic and seventh abdominal segments, and a similar but fainter, scarcely perceptible, suprastigmatal stripe; lower part of the body more pallid than above with a slight greenish tinge, wholly lacking the warm tints of the dorsum; first thoracic segment pallid, the shield corneous, black in a very narrow stripe or line, broken in the middle above. Legs pale at the base, luteous beyond, the claw dusky; prolegs concolorous with body. Spiracles luteo-castaneous centrally, with a dark castaneous rim. Length when contracted, 21.5 mm.; breadth of body, 5 mm.; of head, 3 mm.

Distribution (31: 8). This butterfly, like the preceding, is a member of the Alleghanian fauna, but it has even been reported from Georgia (Edwards); excepting this its southernmost known stations are West Virginia and Washington (Edwards); westward it has been taken as far as Illinois (Worthington) and eastern Kansas, rare (Snow), but northward it does not reach the boundaries of the Canadian fauna, having been taken only as far north as Albany and Sharon Springs, N. Y. (Lintner). That this statement may be greatly modified by later information is shown by its having been taken by Geddes at Calgary, Alberta.

In New England it is confined to the southern portions and is everywhere exceedingly rare; a single specimen has been taken at Milford, N. H. (Whitney); others have been obtained at Mt. Tom (Morrison, Dimmock), South Hadley and Amherst Notch (Sprague) and Springfield, Mass. (Emery, Dimmock) and at Farmington (Norton), Oxford (Harger—Mus. Yale Coll.) and Guildford, Conn. (Smyth—Mus. Yale Coll.).

Life history. The butterfly is single brooded but the mode of hibernation is uncertain. The earliest butterflies make their appearance the very last of June—sometimes as early as the 22d, but it is not until about the 4th of July that the insect becomes abundant and it flies throughout this month. Like its congener this butterfly is very fond of flowers exposed to the hottest sunshine and may easily be taken when feeding on the blossoms of *Asclepias*. The caterpillar is very inert, and in confinement in a closed box, eats by day as well as by night. It feeds on grass.

Desiderata. The exact history and careful descriptions of its early stages are our principal needs with regard to this insect. Plainly we have much to learn about its distribution not only over the southern part of New England but especially throughout the west; the peculiarities of the flight and posture of the imago and the parasites of its early life are lesser though important deficiencies.

LIST OF ILLUSTRATIONS.—EUPHYES VERNA.

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|---|--|---|--|
| <i>General.</i> | | <i>Imago.</i> | |
| Pl. 31, fig. 8. Distribution in North America. | | Pl. 10, fig. 27. Female, upper surface. | |
| <i>Egg.</i> | | 33. Male, both surfaces. | |
| Pl. 66, fig. 35. Colored, and outline enlarged. | | 37: 35. Male abdominal appendages. | |
| <i>Caterpillar.</i> | | 43: 17. Discal stigma of fore wing of the male. | |
| Pl. 77, figs. 25, 26. Mature caterpillars. | | 50: 3. Scales of the discal stigma. | |
| 80: 65. Front view of head in fifth stage. | | | |

CALPODES HÜBNER.

Calpodes Hüb., Verz. bek. schmett., 107
(1816).

Calpodes Hüb., Ibid., Anzeiger 5 (1816).
Hesperia pars Auctorum.

Pamphila pars Auctorum.

Thracides Burm., Rev. n. ag. zool., 1875, 55
(1875).

[Not Thracides Hübner.]

Type.—*Papilio ethlius* Cram.

See how slowly the streamlet goes;
Look how the violet roguishly hides;
Even the butterfly rests on the rose,
And scarcely slips the sweets as he goes.

CAROLINE GILMAN.—*Child's Wish in June.*

Imago (60:3). Head very large, heavily clothed with large, transverse masses of short hairs; just outside the antennae a short, spreading, appressed tuft of slightly arcuate bristles not extending more than one-fifth way around the eye. Front tumid and very protuberant, the whole extending far beyond the front of the eyes, increasingly so from above downward; each lateral half transversely arcuate, and the middle of the whole broadly hollowed with a slight, longitudinal, median ridge; slightly hollowed as it approaches the antennae, nearly four times as broad as long, the front edge with either lateral half arcuate, sloping off toward the outer edge of the antennae, where the piece is quite slender and in the middle of the front causing a conspicuous excision; separated from the vertex by a scarcely impressed straight line, connecting the middle of the antennae. Vertex tumid, raised above the level of the eyes almost as much as the front, and most so in the middle, transversely, very slightly and regularly arcuate. Occiput highest in the middle, sloping off at either side with a slight, median, longitudinal furrow, toward which the slightly impressed line separating vertex and occiput slopes a little; this line is otherwise straight on either side, a little bent in the middle. Eyes large, pretty full, nearly circular, naked. Antennae inserted slightly in advance of the middle of the summit in very broad, shallow depressions, and separated from each other by about four times the diameter of the basal joints, the whole antenna as long as the body and composed of forty-two (or forty-three?) joints, of which twenty-three form the club, which is about half as long as the stalk; the crook excluded, nearly four times as long as broad, rather slender, oval, largest at about the middle and tapering gradually toward either extremity, scarcely more so toward base than toward tip; crook consisting of eight joints, forming a long and very slender, delicately and regularly tapering appendage, fully four times as long as the breadth of its base, and nearly half as long again as the breadth of the club; middle joints of the stalk about three, the third from the base of antennae about four times as long as broad. Palpi exceedingly stout, less than half as long again as the diameter of the eye, covered with a very heavy, compact mass of scales, appressed in front, its outer edge bounded by a thick, slightly projecting wall of stiff bristles, and attenuating above so that the top appears wedge-shaped, and beyond the middle of which the apical joint, also very heavily clothed, scarcely projects; basal joint bullate, subpyriform, much broader than long, with a large tumid expansion, at the inner anterior part of the extremity, curving upward; middle joint large, bullate, as broad as the basal joint, broadly oval, well rounded at every part, regularly rounded at the base, obliquely docked at the tip from within outward, but with broadly rounded edges, flattened interiorly, a little arcuate, less than twice as long as broad; terminal joint seated a little outside the middle of the extremity, small, obovate, bluntly and equally pointed at either end, fully twice as long as broad, and scarcely more than one-third as long as the breadth of the middle joint.

Prothoracic lobes moderately large, appressed, laminate, triangular, the inner and lower sides nearly straight and equal and at right angles to each other, the other side arcuate, scarcely longer than high, and equal to the shorter diameter of the eye. Patagia rather larger, nearly as long as the breadth of the head, the posterior lobe long

and slender, half as broad as the base, nearly four times as long as broad, straight, equal on the basal half, tapering on the apical half, the tip rounded.

Fore wing (42:14) two and a half times longer than broad, the lower outer angle falling scarcely outside the middle of the costal margin; costal margin straight with the slightest possible deflection at either extremity; outer margin gently convex with a scarcely perceptible bend in the upper median area; inner margin straight. Costal nervure extending nearly to the apex of the cell; subcostal very closely approximate to the costal margin, the second nervure arising in the middle of the wing; cell two-thirds as long as the wing, excessively slender, subequal in the apical two-thirds; first median nervure arising midway between the base of the wing and the origin of the second nervure, far before the base of the first subcostal nervure; the second opposite the second subcostal nervure; just beyond its origin a short, recurrent nervure is seen; internal nervure straight, pretty short.

Hind wing a little longer than broad, the basal lobe large; costal margin beyond straight; outer margin between the costal nervure and lower median nervure regularly and strongly convex; below this, where the wing is unusually broad, there is a distinct full, rounded lobe, with the submedian nervure at its fullest point; anal angle well rounded.

Legs, 2, 3, 1. Femora furnished beneath with a fringe of hairs, decreasing in length toward the tip; they are very long on the hind legs, moderately long on the middle legs, and very short on the fore legs; hind tibiae furnished above with an abundant fringe of long, but partially recumbent hairs upon the outer side. Femora 2, 1, 3; tibiae 2, 3, 1; tarsi 3, 2, 1. Fore femora perceptibly longer than the hind, and about three-fourths the length of the middle femora. Fore tibiae scarcely two-thirds the length of the fore femora, and about three-fifths the length of the middle tibiae, which are but little longer than the hinder pair. Leaf-like appendage of fore tibiae rather small, attached to the middle of the outer two-thirds of the joint, nearly equal as far as the extremity of the joint, where it tapers to a point and is bent very strongly downward, the whole not far from five times as long as broad; other tibiae armed at the tip with a pair of exceedingly long and slender unequal spurs, and the hind tibiae with a similar secondary pair in the middle of the apical two-thirds of the joint; the two hinder tibiae are also provided exteriorly with a lateral row of distant recumbent spines. Tarsal joints 1, 2, 3, 4, 5; fore tarsi three-fourths the length of the middle, three-fifths the length of the hind tarsi, all furnished beneath with a triple row of rather short spines, those at the extremity of the joints scarcely, if at all, longer than the others; basal joint fully as long as the others taken together; second only two-fifths as long as the basal joint, or even slightly less than this on the fore legs. Claws small, compressed, curved strongly and regularly, tapering to a point. Pad large, bulbous. Paronychial bilobed, the upper lobe laminate, broadly falcate, as long as the claw; lower lobe thread like, equal, half as long as the claw.

Abdominal appendages: Upper organ small but stout, strongly convex transversely, narrow and well arched, the simple hook curving downward, provided with a median ridge above; lateral arms connate, forming a triangular piece somewhat similar to and lying beneath the hook. Claspers broad, flat, equal, laminate, about twice as long as broad, as long as the upper organ, the upper posterior angle slightly produced as a tooth.

Egg. Almost exactly hemispherical, a little more than half as high as broad; basal breadth retained for about one-tenth its height, beyond which it is domed with the greatest regularity, there being not the least appearance of flatness on the summit, though in the centre the micropyle is slightly depressed; surface covered with a reticulation of very regular cells, the floor of which is profusely punctate.

Caterpillar at birth. Head large, narrowed and subtuberculate above with very distant, short, tapering bristles, the median suture deeply impressed. Body exceedingly long, slender, equal; dorsal thoracic shield rather broad, uniform; bristles very short and slight, hardly one-tenth the length of the segments, scarcely tapering, rounded at tip, and with a scarcely perceptible enlargement, arranged as follows: a

laterodorsal series placed anteriorly; a lateral series placed posteriorly; a suprastigmatal series placed centrally and an infrastigmatal series, two to a segment, the anterior subcentral; last abdominal segment with two or three pairs of long, slightly recurved bristles, longer than the segments.

Mature caterpillar. Head rounded, triangular or pyramidal, of about equal height and breadth, broadest at the summit of the ocellar field, tapering above to a truncate apex, the summit of each hemisphere independently domed, very broadly and gently rounded beneath, much deeper below than above, the whole face almost appressed, the sutures gently impressed, the whole surface subrugulose, with a subpolygonal net work of slightly and bluntly elevated, ill defined lines. Triangle roundly emarginate across its entire base, half as high again as broad, the sides approaching more rapidly at the extreme tip, so that they join at little less than a right angle about the middle of the front. Antennae with the first joint very broad, scarcely elevated, like a low, broad tubercle; second joint very much smaller and so longer, cylindrical, shorter than broad; third half as broad as the second, cylindrical, about three times as long as broad; the fourth minute, cylindrical, the bristle of third joint curved, tapering, about as long as the antenna. Ocelli six in number, four in a nearly straight line, the lowest as far from the next as the upper of the four, the second midway between the first and third; a fifth above the others and forming with the upper three of the four first mentioned a gently curving line, convex anteriorly, and more curved above than below, equidistant; the sixth smallest and placed behind the lowest of the curving row just mentioned, and as far behind as it is in front of a line uniting the uppermost and lowermost of all the ocelli. Labrum very small, cleft narrow, to the base so as to be bilobed. Mandibles small, but massive, without dentation. Joints of maxillary palpi of nearly equal length and ever decreasing size apically.

Body largest on fifth and sixth abdominal segments, tapering toward either end, flattened beneath. Flattened cylindrical above, everywhere larger than the head even on the thoracic segments, excepting the collar-like first segment; the front part of the body capable of a great extension, the last segment flattened, broad, apically semicircular. Segments divided transversely by rather deeply impressed lines into several divisions, an anterior taking up rather more than half the segment, and itself partially subdivided by lines which are not continuous on the sides, into a middle, larger section and equal anterior and posterior sections; and five posterior divisions or folds, of which the hindmost is considerably larger than the others, which are equal; the body is almost entirely naked, having only a few scattered, short, equal, microscopic hairs on scarcely perceptible tubercles, besides a few longer, tapering hairs on the sides. Spiracles not very large, broad, ovate, with prominent rims. Legs normal and equal, the claws with a basal tubercle. Prolegs rather large, tapering but little.

Chrysalis. Very long, cylindrical, slender, the thorax scarcely elevated, almost straight and equal from the eyes to the end of the sixth abdominal segment, beyond that tapering rapidly and regularly; front transverse, rounded, developing at its upper centre a slender, forward projecting, upcurved, tapering horn, longer than the head; prothoracic spiracle lanceolate, arcuate, not at all elevated, lateral; wings a little produced at the extremity, and just reaching the tip of the fourth abdominal segment; tongue free beyond the wing cases and extending far beyond the tip of the abdomen; fore wings and antennae of equal length, reaching the middle of the first abdominal segment; hind legs just exceeding the wings; prothorax with a transverse series of four subequidistant, abruptly raised, transverse, oval, minute lenticles along the anterior edge, the outermost in front of the spiracles; abdomen with a laterodorsal series of similar lenticles, but in saucer-shaped depressions, two to a segment, one in the middle of each half, the hinder slightly more separated than the anterior; five succeeding abdominal segments with an infrastigmatal series of similar lenticles on the anterior half of the segment; cremaster profoundly sulcate above, leaving a thickened, ribbon-like rim on either side, forming flattened carinae, which at first approach each other rapidly, afterward run side by side; similarly sulcate laterally at base and separated again by a longitudinal ridge from the slightly sulcate, inferior face; the field of anal hooklets altogether terminal, slightly transverse, the hooklets crowded.

This is a tropical genus peculiar to America, found both on the mainland and in the Antilles, and extending beyond the tropics, both north and south, to a distance of at least two degrees. One species has once been taken near the confines of New England—perhaps accidentally introduced.

The butterflies are among the very largest of their tribe, almost vicing in size with the larger *Hesperidi*. The males possess no discal spot. The wings are dark brown, flecked heavily with tawny beneath, and both wings traversed by three or four moderately large, vitreous spots, lying in a line from the upper outer angle to the middle of the inner margin, sometimes forming a continuous band on the under surface of the hind wings; besides, there are a few minute spots in a transverse series near the apex of the wing.

The transformations have been figured by Stoll and Burmeister.

The eggs are hemispherical in shape, white, with a delicate reticulation, and covered with an efflorescence; they are laid in little, open groups of from three to seven.

The caterpillar feeds on *Canna*; at first white, afterwards dark greenish, finally pale green and covered with a whitish bloom, the skin is so transparent that the internal organs are readily seen; it is greatly elongated, tapers toward either extremity, its head much smaller than the largest part of the body. It lives solitarily in a rolled-up leaf stitched into place, and lies lengthwise the leaf.

The chrysalis is remarkable for the elongated form, the tapering, pointed and upcurved frontal projection, and the length of the tongue case, which extends to some distance beyond the tip of the cremaster. It is enclosed in a cocoon, which is nothing but a tighter larval case, and hangs suspended by two loops; the abdominal at least, and probably both, taking the form of a Y.

EXCURSUS LXXIV.—ODD CHRYSALIDS.

Knowledge this man prizes best
Seems fantastic to the rest:
Pondering shadows, colors, clouds,
Grass-buds and caterpillar-shrouds.

EMERSON.—*Woodnotes*.

ONE of the patent facts in the study of *Lepidoptera* is the variety of character assumed by the chrysalis, as soon as in the higher butterflies it becomes exposed to the light of day. In the moths and the *Hesperidae* they are wholly concealed and accordingly show a pretty dull uniformity, the differences being slight and insignificant. To a large extent this is also true of those that are tightly girt and immovable; but the moment we come to exposed and swinging chrysalids, at once they assume a new interest, which natural selection appears to have discovered before us and to have been at her old experiments.

So it comes about that at every point that could bear a special development, we have in one or another form some special prominence, in not a few cases producing a curious effect and bizarre forms. Even our own butterflies are not wanting in some such oddities. The closer one examines the chrysalis of our *Papilio* or *Heraclides* the more do they seem to resemble a broken bit of rough bark. *Calpododes* has an odd hook in front. *Callidryas* with its bent back, protuberant wings and pointed snout has a curious air of pride. *Anthocharis* looks like a doubly sharpened stick. The acc-of-spades form and baboon features of *Feniseca* are very amusing. The prickly ragged edges of *Pieris* have a noli-me-tangere look; and what a swollen and yet pinched appearance belongs to *Laertias*! Oddest of all, perhaps, is the curiously formed lumpy shape of *Basilarchia* with the Roman nose on its back and its strange commingling of colors.

But as in all else, we must gain the tropics to find the greatest oddities, where we have not far to seek them among the prickly *Heliconinae*, the long eared *Ageroniinae*, *Eucides* that looks as if afflicted with a fungous growth, or some species of *Cynthia* of quite indescribable form, its prominences, of most extravagant development, in most unlooked-for places. More apparently than in any other stage of a butterfly's life, has nature played freaks with the chrysalis.

CALPODES ETHLIUS.—The Brazilian skipper.

Papilio ethlius Cram., Pap. exot., iv: 212, 249, pl. 392, figs. A, B (1782).

Hesperia ethlius God., Encycl. méth., ix: 717, 746 (1819);—King, Psyche, iii: 322-324 (1882).

Goniloba ethlius Westw.-Hew., Gen. diurn. Lep., ii: 513 (1852);—Luc., Sagra, Hist. nat. Cuba, 633-634 (1857);—Gundl., Entom. cub., i: 160-162 (1881).

Pamphila ethlius Herr.-Schaeff., Corresp. zool.-min. ver. Regensb., xix: 54 (1864);—Gundl.-Dewitz, Zeitschr. ges. nat., iii: 158-159, pl. 2, figs. 3, 3 a, b (1879);—French, Butt. east. U. S., 332-334 (1880);—H. Edw., Ent. amer., iii: 163 (1887).

Epargyreus ethlius Butl., Cat. Fabr. Lep., 275 (1869).

Pamphila (*Calpododes*) *ethlius* Butl., Ent. monthl. mag., vii: 93 (1870).

Calpododes ethlius Soudd., Syst. rev. Amer. butt., 61 (1872).

Thracides ethlius Burm., Rev. mag. zool., 1875, 55-58, pl. 1, figs. 5, 6 (1875); Desc. phys. Rep. Argent., v: 275-279 (1878); Ibid, Atlas, 25, 26, pl. 9, figs. 5, 6 (1879).

Hesperia chemnis Fabr., ent. syst., iii: 331 (1793);—God., Encycl. méth., ix: 717, 746 (1819).

Eudamus olynthus Boisdu.-LeC., Lép. Amér. sept., pl. 75, figs. 1, 2 (1833).

Goniloba olynthus Westw.-Hew., Gen. diurn. Lep., ii: 512 (1852);—Morr., Syn. Lep. N. Amer., 113 (1862);—Dodge, Rural Carol., iii: 593-594 (1872); Field and for., i: 73-74 (1876).

Figured also by Glover, Ill. N. A. Lep., pl. 109, fig. 13 (2 fig.); pl. F, fig. 26, pl. T, fig. 2, ined.

Vanishings
Of glory, with Aeolian wings
Struck him and passed.

E. B. BROWNING.—*A Vision of Poets*.
Away you go, with eager vehemence, ready and rough.

ARISTOPHANES.—*Wasps*.

Imago (17: 14). Head covered above with profuse, short, mingled pale olivaceous gray and dark olivaceous brown hairs, the eye encircled with pale dirty yellowish scales, palest beneath, replaced by very short hairs above and briefly interrupted with

black midway between the antennae and the back of the head; a lateral, compressed transverse tuft of not very long, bristly hairs at the external base of the antennae and passing behind them. Palpi gray with mingled blackish brown and whitish scales, the latter becoming tinged with yellowish brown on apical half; along the angle formed by the frontal and lateral face of palpi at rest is a row of slightly longer, stiff, black hairs, rising more beyond the surface on the apical than on the basal half; terminal joint brownish below, blackish brown above. Antennae pretty uniformly brownish fuscous, enlivened with scattered, dull silvery scales along the basal third, frequent pale golden scales along the middle third of the inferior surface of the stem, while the apical third is entirely golden, extending upon the basal third of the heavy part of the club and even tingling the upper surface of the base of the club; club, excepting parts mentioned, dull blackish, the crook brown. Tongue black, the apical third castaneous.

Thorax above olivaceous, the erect, brown scales of prothorax tipped with pale yellowish; beneath yellowish gray. Legs pale buff, the femora lined anteriorly with purplish brown, fringed beneath with silvery scales and yellowish gray hairs; the tibiae paler buff below and behind, and darker approaching close to brown above, the tarsal pretti uniformly dull buff, the terminal joints a little darker. Spurs pale dull buff, spines reddish testaceous; appendages at extremity of legs dark, dull reddish.

Fore wings rich dark brown, scarcely tinged with olivaceous, sprinkled with elongated, pale honey fulvous scales, brighter and much more abundant on the inner than the outer half, occurring along a rather broad band upon the costal margin, and a somewhat narrower one along the outer margin; an ill-defined streak of similar scales, olivaceous above, paler below, occurs along the upper margin of the median vein from the base to a little beyond its first divarication; just below the same nervure, in the ♂ at least, but occupying a little shorter space, is a row of downward and outward directed, pretty long, mingled fulvous and brownish hairs; and along the inner border, at a little distance from the base, is a longitudinal, slightly oblique streak of long, dirty golden yellow hairs, reaching next to the outer limit of the spot in the medio-submedian interspace presently to be mentioned. There are five larger vitreous spots upon the wing: the largest crosses the lower median interspace, its inner edge starting from midway between the two divarications of the median; it is subquadrate, slightly broader than long, a little oblique and with its lower outer angle a little produced to heighten the effect of its obliquity; another spot about half as large, rudely triangular, is situated in the medio-submedian interspace, its longer side upon the submedian nervure, its inner extremity scarcely beyond the middle of the nervure; it reaches half way across the interspace; the third in size is in the first median interspace, is subulate, opening outward and is situated less than its own width from the very base of the interspace; a fourth, scarcely smaller and longitudinally quadrate, is in the cell seated on the median nervure, its outer edge on a line with the inner edge of the largest spot; the fifth and smallest, very small and oval, is also in the cell directly above the inner edge of the fourth; besides these there are three other minute similar spots: one transverse and linear in the centre of the subcosto-median interspace, the others nearly square, approximate, the lower directly above the first and separated from it by one interspace, but the upper, in the next interspace beyond, a little within that line. Fringe dark, almost blackish brown on the basal portion, and to a greater extent above than below the lower median nervure, the apical portion dirty pale greenish yellow above, brighter, more honey yellow below. *Hind wings* a little darker than the fore wings, but concealed toward the base by abundant, long, longitudinally recumbent, rufo-fulvous hairs, extending in the lower half of the wing more than three-fifths the distance to the outer margin and on the lower half of the upper half of the wing considerably more than two-fifths the distance from base to outer margin; there are three vitreous spots near the middle of the wing arranged in a nearly straight row at right angles to the inner border, the middle barely lower than the others; they are of nearly equal size, about as large as third and fourth spots of fore wings, quadrate-subulate in shape, the upper one in

the subcosto-median interspace indistinctly broken by the longitudinal fold in the middle of the interspace, the other two in the median interspaces, the lower having its outer edge at the centre of the interspace; the fringe is uniform pale honey yellow, partially covered on basal fourth with brownish fuscous, the whole partially obscured by fuscous along the inner margin.

Beneath, dull snuff brown, the disc of the fore wings, from the upper limit of the cell to the inner border and reaching so far as to include the outer of the large vitreous spots and from thence downward to the tip of the inner margin, brown, darker in the middle of the wing. *Fore wings* with the same vitreous spots as above, a little more distinct; fringe nearly uniform with the neighboring parts of the wing, the apex above the lower median nervule tipped with brown. *Hind wings* uniform, with the same vitreous spots as on the upper surface, the upper more distinctly divided. Fringe, with the basal one-third of the portion above the lower median nervule and the whole of that along the inner margin of the color of the wing, the rest partaking more of the color of the upper surface of the fringe.

Abdomen above dark brown, covered with many fulvous hairs; beneath pale yellowish white, interrupted by transverse, indistinct bars of brownish fuscous, near the bases of the segments; claspers of male furnished with yellowish hairs. The upper organ of the male appendages (37:34) has the hook scarcely longer than the centrum, tapering regularly and rapidly to a blunt point; basal half with a heavy compressed ridge; lateral arms smaller than the hook and curved a little in a reverse sense. Claspers with the inferior margin slightly and roundly excised near the middle, the posterior margin nearly straight and the upper posterior angle produced to a small laminate and triangular tooth, a little incurved.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 28.5 mm.						
Length of fore wing.....	23.		24.	22.		27.
antennae.....	9.		9.1	8.5		10.
hind tibiae and tarsi...	11.		12.5	11.		14.
fore tibiae and tarsi...	7.		7.5	6.		8.

Egg (66:34). The cells at the extreme base of the egg are about two and a half times broader than long; and a short way above they are mostly of equal height and breadth, sometimes perfectly square, but usually irregular, quadrilateral, lozenge-shaped or pentagonal, above usually pentagonal but very irregular; where they average of an equal diameter they are about .03 mm. in breadth; the surface of the cells is shallowly, uniformly and rather closely punctate, the punctae about .005 mm. in diameter, numbering about twenty-five to thirty in a cell, ranged in tolerably straight rows; the micropyle (69:15) consists of about seven kite-shaped cells arranged symmetrically round a central circle and entirely free of the punctae; the central circle is about .007 mm. in diameter, the kite-shaped cells are about .015 mm. in their longer axis, and the whole circlet of cells about .035 mm. in diameter; this circlet is immediately followed by cells about .025 mm. in length and about .02 mm. in breadth. Height of egg, .68 mm.; diameter, 1.25 mm.

Caterpillar. First stage. Head piceous with very faint, transverse punctae or short striae very slightly impressed; mouth parts fuscous. Body pale yellowish brown; dorsal thoracic shield blackish; anal plate edged with luteous; bristle pellucid, those of the last abdominal segment fuscous; thoracic legs testaceous, all the pairs alike; prolegs concolorous with the body; hooklets testaceous. Length of body, 3.5 mm.; breadth of body, .5 mm.; of head, .7 mm. Described from specimens preserved in glycerine.

Second stage. Head uniform yellowish brown, the surface delicately reticulate with blackish fuscous, forming very small angular cells; the triangle free from them and somewhat lighter in color; ocelli pellucid with a blackish annulus at the base of each. Body dirty yellow, somewhat infuscated along the sides, flecked with dull fuscous, minute papillae sparsely scattered over the body, supporting minute, excessively short,

fungiform, pellucid or white papillae; dorsal thoracic shield blackish fuscous. Length, 5 mm.; breadth of body, 1 mm.; of head, 1 mm. From specimens preserved in glycerine.

Third stage. Head (80:72) uniform luteous as before, reticulate with fine blackish fuscous raised lines at their angles having slight papillae, bearing excessively short, pellucid hairs; ocelli pellucid in a black field; labrum and mouth parts blackish fuscous. Body transparent, permitting all the internal organs to be seen and therefore in blown specimens colorless; dorsal thoracic shield yellowish brown, infuscated; the minute papillae of the body blackish fuscous; spiracles, including the prothoracic, pallid; thoracic legs pale fuscous, the basal joint mostly concolorous with the body, as are the prolegs. Length, 20 mm.; breadth of body, 2.5 mm.; of head, 1.6 mm. From blown specimens.

Fourth stage. Head (80:73) luteous, much clouded with fuscous, especially in a vague stripe and down the face on either side of and slightly distant from the median suture; the reticulation, ocelli and mouth parts as before; other parts as in the last stage. Length, 28 mm.; breadth of body, 4 mm.; of head, 2.3 mm. From blown specimens.

Last stage (77:20). Head (80:74) dark orange, deepening somewhat in tint toward the summit, the upper half of the triangle, the ocellar band and the mandibles piceous. Body green, the spiracles pallid with a piceous rim, surrounded by a fuscous cloud of greater or less extent, varying in different individuals and on different segments, the tracheal stems being also visible through the transparent walls of the body as infuscated radiating and fading rays. First thoracic segment greenish testaceous, the lower extremities of the shield marked with black. Legs concolorous, but the second and third joints and the apical rim of the first joint of the first pair infuscated exteriorly, deepening sometimes to blackish and extending on the third joint entirely around the leg; claws luteous. Prolegs concolorous, the claws luteo-testaceous. Length, 47 mm.; breadth, 5-6 mm.; width of head, 3.5 mm. Described from blown and alcoholic specimens.

Another description. The following description of the living animal is taken from the notes of Dr. Gundlach. Head dark orange; mouth parts, ocelli and frontal triangle black. The body with a transparent skin and a whitish line on either side of the back; the color would be of a very pale bluish green but because all the inner organs may be distinguished the appearance is greenish gray; all the tracheae are clearly visible, as is also a white line between the stigmata [the tubes connecting the tracheal vessels] and two pairs of subcutaneous yellowish white lines under the anal plate; the first thoracic segment very pale bluish green, the spiracle black; the other spiracles are white with pale yellow borders; thoracic legs of the general color, but the first pair have the base black on a roseate ground; second pair with only a little black spot at the base; the ventral surface of the apodal abdominal segments covered with a white powder.

Chrysalis (85:48). General color very pale green; the whole surface transversely and minutely corrugated, furnished with exceedingly sparse and excessively short, very delicate, erect hairs; on the middle of the mesothorax they are longer, stouter and more abundant though still sparse, and curved backward, seated everywhere on minute papillae; a series of laterodorsal, transversely oval, flattened lenticles, each placed in a depression of the general surface, black in color, situated a little in advance of the middle of the anterior and a little behind the middle of the posterior half of the second to the eighth abdominal segments, the anterior ones slightly nearer together than the posterior; the posterior one is also found upon the first abdominal segment and near the middle of the mesothorax; the anterior one is again found near the anterior edge of the prothorax and an additional lenticle upon the prothorax just in advance of the prothoracic spiracle, here somewhat oblique; wing cases and legs whitish; tongue dark green; stigmata yellowish; cremaster whitish; frontal tubercle ferruginous, the upcurved extremity black. Length from tip of frontal tubercle to tip of cremaster, 36 mm.; length of frontal tubercle, 3 mm.; of cremaster, 3 mm.; of free portion of

the tongue, 21-24.75 mm.; breadth of body at head, 6.5 mm.; of extreme base of cremaster, 2 mm. Described from dried specimens and the notes of Dr. Gundlach.

Mr. Henry Edwards describes the color of the chrysalis after exclusion as a pale buff, the surface with a slight mealy covering; and he adds, "In the male chrysalis the spiracles are marked with black dots, in the female they are concolorous with the rest of the body."

Distribution (32:5). This butterfly, whose proper home is Central America and the northern parts of the South American continent, inhabits also the extreme southern states of our Union. It has been reported so far only from the Gulf states and South Carolina; in the latter from Bluffton (Riley) and Charleston (Dodge). It is found everywhere in Florida and in Texas, at least as far as San Antonio (King). It occurs also in all the Antilles, or at least in the larger islands, Cuba, Jamaica and Porto Rico, and in South America extends at least as far as the Argentine Republic, where Burmeister has found it common.

The only reason for its introduction here is that it was once taken by Mr. James Angus in West Farms, near New York. Whether this was an accidental occurrence or a commercial introduction to New York City can only be told by a careful survey of the butterfly fauna of the Atlantic seaboard.

Oviposition. The eggs are laid singly and separately, but according to Burmeister, in groups of five to seven, on the under surface of leaves; but Dr. Wittfeld says they are laid on the upper side on the same genus of plants as Burmeister, "plainly visible and therefore much exposed to destruction." Some which he sent me were, however, laid on the under surface, in groups of three, almost touching. They hatch in Texas, according to Helen King in six days; Wittfeld says four days in southern Florida.

Food plant and habits of caterpillar. The caterpillar appears to feed only on some species of *Canna* or Indian shot, one of the Cannaceae. In our southern states it is *C. flaccida*, in Cuba *C. indica*. Sometimes they are so abundant as to do much damage, having, in one instance reported to me by Dr. Riley, "utterly destroyed some luxuriant plants" in Dr. Mellichamp's garden in South Carolina.

On hatching, the caterpillar devours the greater part of its egg, sometimes all but the floor, too closely adhering to the blade to be bitten. "Having eaten a small portion of the leaf," says Helen King, "the larva folds this over and confines it to its place with a few stitches of silk, enlarging this temporary retreat, or folding a new section, as it grows. . . . It feeds from this tubular case, just along the edges, retreating within when alarmed. It forcibly ejects all excrement from the upper, free end, together with all exuviae, so that, although it evidently sheds its skin several times, these cast skins cannot be found. The larva increases more rapidly in size at its early stages than later, and doubles its length in

twenty-four hours" (Psyche, iii:323). She adds that "in a few hours" after hatching, the first moult is passed; but Wittfeld says not for three days.

At times when the larva is undisturbed, there seems to be an almost total suspension of motion in the spiracles and in all the parts affected by them. With the entrance of air into the system of spiracles there is a regular pulsating movement in the dorsal vessel, and in the small four-chambered bodies in the ninth segment [ovaries]. The entrance of air into the posterior pair of spiracles seems to give the initial impulse which travels so rapidly along the series and its ramifications that almost immediately the head of the insect begins to move from side to side as if affected by the same influences which affected the other parts. This occurs when the leafy covering of the larva is cut open and light and air admitted.

The first conscious effort of the larva when its sheath [nest] is opened is directed toward the elaboration of silk fluid with which to enclose itself once more within its case. With this purpose it eats rapidly and the silk fluid is seen at the same time accumulating in and near the thoracic segments. The larva uses its short, black, front pair of feet to unite the threads which it spins back and forth, forming a cord of fifty to seventy-five threads, as may suit its purposes. (King, Psyche, III: 323-324.)

Mr. Charles R. Dodge remarks of some caterpillars received by him in Washington, placed in a breeding cage and supplied with tender leaves of *Canna*, that they devoured these "with avidity, having first curled the leaf just enough to form a convenient hiding place," although, he adds, "they do not confine themselves exclusively to it, for more than once they were observed stretched out at full length on the foliage, or on one of the sides of the box."

Pupation and cocoon. The same observer states (Rural Carolinian, iii: 593) that "when about to change to pupae . . . they fold the sides of the leaf closer together, fastening it with silken threads in the same manner as many of the Tortricidae, and cover its entire inner surface with a web of white silk, so fine that it resembles a white powder. Two slight threads or loops, one across the thorax and another at the end of the body to which the tail is fastened, serve to keep the pupa in place."

Mr. Dodge was good enough to send me some of these cocoons which I find made, as stated by him and by H. Edwards, of a rolled up blade of *Canna*, so that the chrysalis lies lengthwise with the leaf. Burmeister, on the other hand, states that the chrysalis is enclosed in small *fragments* of *Canna* leaf rolled into the form of a cylinder, carpeted on the interior with dense tissue and held in place by two transverse bands placed one in the middle of the body, the other at the hinder extremity; but he does not state *where or* in what way this cocoon is held in place. I observed that the caterpillar had carpeted the whole interior of the rolled up leaf with strands of a cottony white silk, the whole carpet equal, uniform, and so thin as in no way to conceal the veins of the blade; a little in advance of the middle it had formed a loop, but whether this were a simple loop or constructed in the ordinary Y form of the *Hesperidae*, I could not determine because in the

two specimens seen, a drop of gum used in securing the cocoon to its support had fallen upon this part: at the hinder extremity, in one instance at a distance of 24 mm. from the thoracic loop, a stouter Y-shaped loop was formed, into which the cremaster was plunged; the forks of the Y are 2 mm. long; the stem, which is much stouter than the forks, scarcely 1.5 mm.; at the point of junction the threads of the fork are much thickened and the forks at their extremity 7.75 mm. apart; the stem of the Y is on a line midway between the two attachments of the thoracic loop, so that if the latter is also Y-shaped, the two Y's are reversed in relative position; in the second example, the hinder Y is similar but the forks of the Y are more widely spread and in the middle portion of the strand thus formed, over a distance of fully a millimetre, it is thickened to double its ordinary size, while the threads of the stem are not made into a single strand but disposed over the whole of this thickened portion and attached over a comparatively broad space at their other extremity, crossing one another to a greater or less degree.

The pupal period in South Carolina, according to Dodge, is seven to eight days; Wittfeld gives the same period for southern Florida; Helen King gives nine days for Texas; Gundlach nine days for Cuba; but Burmeister says a fortnight (quinze jours) in Buenos Ayres.

Life history. Data for the history of this insect are excessively meagre. In southern Florida the butterfly is on the wing in May and from eggs laid in the middle of the month, the butterflies again appear in the first half of June. In South Carolina mature caterpillars may be found before the middle of June and fresh butterflies from the 12th to the end of the month. There are, therefore, at least two broods before mid-summer, but how many more there may be later, or how the winter is passed is altogether unknown.

The motions of this hesperid are "very rapid," according to Helen King. Mr. Angus says he was attracted to the individual he captured near New York "by the peculiarity of its movements on the wing; they were very undulating, much like those of some gnats, as they rose and fell almost perpendicularly and in a very easy manner." Wittfeld says that one of its favorite feeding times in fair weather is after sundown.

Desiderata. Persons collecting in warm spots along the low country skirting the sea in New Jersey and southward should be on the lookout for this insect to enable us to judge whether the single instance of its capture in New York is due to an accidental introduction in chrysalis from our southern ports or Brazil, or whether it does occur scantily along the whole Atlantic seaboard south of New York. A more careful examination of the cocoon should be made to discover the reason for the different observations of Burmeister and others and also to inquire as to the exact structure of the median girth. The merest fragments of its life history are given above

and much no doubt may be learned concerning the habits of a caterpillar so different from the great majority of our Pamphilidi. The habits of the butterfly should also be observed and special inquiry made into the possible parasites of the insect.

LIST OF ILLUSTRATIONS.—CALPODES ETHLIUS.

General.	<i>Chrysalis.</i>
Pl. 32, fig. 5. Distribution in North America.	Pl. 85, fig. 48. <i>Chrysalis.</i>
<i>Egg.</i>	<i>Imago.</i>
Pl. 66, fig. 34. Egg.	Pl. 17, fig. 14. Both surfaces.
69: 15. Micropyle.	37: 34. Male abdominal appendages.
<i>Caterpillar.</i>	42: 14. Neuration.
Pl. 77, fig. 20. Mature caterpillar.	69: 3. Side view of head and appendages
80: 72-74. Front views of head in stages III to V.	enlarged, with details of the structure of the legs.

OLIGORIA SCUDDER.

Oligoria* Scudd., Syst. rev. Amer. butt., 61 (1872).	Hesperia pars Auctorum.
	Pamphila pars Auctorum.
	Type.— <i>Hesperia maculata</i> Edw.

Yet once I lived not needing love, I: no.
Oh, 'twas but I as the worm that crawls and feeds
Is the winged rapture drunken with free air
That's playmate to the sunbeams. Oh, this love!
Stello, thou hast given me a soul.

AUGUSTA WEBSTER.—*The Sentence.*

Imago (60: 4). Head large, clothed with transverse masses of rather short hairs; just outside the antennae a short, spreading, appressed bunch of arcuate bristles, passing about one-fifth way around the eye. Front tumid, very protuberant, the whole extending some distance beyond the front of the eyes, increasingly protuberant from above downward; transversely, pretty strongly arcuate, flattened in the middle, hollowed for some distance next the antennae; about three times as broad as long, subquadrate, the anterior outer angles rounded off and the middle of the front border delicately marginate and slightly excised; separated from the vertex by a scarcely impressed, straight line connecting the middle of the antennae. Vertex scarcely tumid, just about level with the surface of the eyes, transversely flat or scarcely arcuate; separated from the occiput which is rather deeply sulcate in the middle longitudinally, by a slightly impressed, brace-shaped line. Eyes large, moderately full, nearly circular, but slightly docked posteriorly, naked. Antennae situated with the hinder edge in the middle of the summit, separated from each other by scarcely more than two and a half times the diameter of the basal joints, the whole antenna a little longer than the abdomen, composed of forty-one joints (♀ not examined), of which twenty-three form the club which is fully half as long as the stalk; the crook excluded, it is more than four times as long as broad, rather slender, cylindric-oval, largest in the middle and tapering very gradually toward the base, more rapidly toward the tip where it is rounded off and bears the very long and slender, delicately tapering and pointed crook, which is composed of nine joints and is four or five times as long as broad and half as long again as the breadth of the club; middle joints of the stalk three times, the third from base of antennae four times as long as broad. Palpi pretty stout, about one and a half times longer than the diameter of the eye, covered profusely with long scales, a little appressed in front on the apical half of the palpi, beyond which nearly the whole of the small apical joint protrudes; basal joint bullate, subpyriform,

* *Chrysopsis*, one lightly esteemed.

slightly longer than broad, slightly appressed, with a not very large, tumid expansion interiorly at the tip, middle joint large, bullate, ovate, in the middle as broad as the basal joint, increasing in size slightly from base to tip, broadly rounded at either extremity, a little arcuate, about twice as long as the greatest breadth, apical joint seated on the middle of the extremity of the preceding, minute, cylindrical, bluntly pointed, straight, about three times as long as broad, but only about half as long as the breadth of the middle joint.

Prothoracic lobes as in Calpodes, three-fourths the length of the shorter diameter of the eye. Patagia pretty large, about four-fifths as long as the width of the head, the posterior lobe half as broad and considerably longer than the base, straight, tapering a very little and rounded at the tip.

Fore wing (42: 16) considerably less than twice as long as broad, the lower outer angle falling well outside the middle of the costal margin; the costal margin distinctly convex at the base, beyond nearly straight, apically declivent; outer margin gently convex, slightly bent in the middle, the apex somewhat pointed, especially in the male. Costal nervure terminating on the costal margin at three-fifths the distance from the base; subcostal tolerably near the costal margin, its second nervule arising scarcely before the middle of the wing; cell two-thirds the length of the wing, moderately slender, broadest in the middle of the apical half; first median nervule arising nearer the second than the base of the wing, the second below the second subcostal nervule; internal nervure short, curving upward to meet the submedian.

Hind wing scarcely longer than broad, the basal lobe pretty large; the costal margin straight, of about equal length with the inner margin; the upper half of the outer margin strongly convex, below nearly straight, well rounded at the anal angle and above it. Median nervure first forking some distance beyond the subcostal, nearly approximated to the second forking.

Legs 2, 3, 1. Hind and middle femora furnished beneath with a fringe of very long hairs decreasing in length toward the tip where they vanish; the fore femora similarly provided out only with short hairs; hind tibiae furnished above with a thin fringe of inconspicuous hairs. Femora 2, 1, 3; tibiae 2, 3, 1; tarsi 3, 2, 1. Fore femora slightly longer than the hind pair, three-fourths the length of the middle femora. Fore tibiae only three-fifths the length of the fore femora, which are but little shorter than the middle and hind tibiae. Leaf-like appendage of the fore tibiae very slender, attached a little before the middle of the basal two-thirds, extending considerably beyond the joint but pretty strongly arcuate throughout, pointed at the tip but otherwise equal, seven or eight times as long as broad. Other tibiae furnished at tip with a pair of very long and slender, unequal spurs and the hind tibiae with a secondary pair, exactly similar, situated in the middle of the apical three-fourths of the tibia; middle and hind tibiae furnished at the sides with spines which on the inside are distant and irregularly scattered, on the outside are very few in number arranged in a regular row. Tarsal joints 1, 2, 3, 4, 5. Fore tarsi about four-fifths the length of the middle tarsi which are scarcely shorter than the hind tarsi, all furnished beneath with three rows of rather long spines, the apical ones of each joint somewhat longer than the others; basal joint equal in length to the second, third and fourth together; second scarcely half as long as the first. Claws pretty small, compressed, strongly serrate, a little bent in the middle. Pad rather small, transverse. Paronychia bilobed, the upper lobe laminate, compressed, subfalcate, nearly twice as long as broad, reaching to tip of claw, gently tapering, bluntly pointed; the lower lobe thread-like, very slender, half as long as the claw.

Abdominal appendages of male having the upper organ moderately large, pretty broad, gently arched; hook a little arched, depressed above, stout, triangular, tapering regularly and rapidly to a very blunt, downcurved point; lateral arms inconspicuous, forming a very slight, triangular lamina beneath the middle of the hook. Clasps as long as the upper organ, about twice as long as broad, nearly equal and scarcely convex, well rounded at the tip, almost unarmed.

This genus consists of a single species bearing a close resemblance to some Australian forms. It is peculiar, however, as far as known, to the southern states of the Union, but has once been taken near New England.

The butterflies are of small size and the males destitute of a discal patch. The wings are almost black with a few very small, whitish spots in an extra-mesial series on both wings, less numerous on the hind than on the fore wings.

Nothing is known of its history or early stages but some brief memoranda given by Dr. Chapman, from which it would appear that the caterpillar is slender and pale green with a light brown head and thoracic shield, and the chrysalis of a dull green with no frontal projection.

EXCURSUS LXXV.—MONSTROSITIES.

Who breaks a butterfly upon a wheel?

POPE.

MONSTROSITIES always have a strange allurements and often contribute not a little to our knowledge of the morphology of the group of creatures in which they occur. Goethe, indeed, said that Nature revealed herself through them; but though we cannot yet expect anything important when gleaning in so narrow a field as the butterflies, it may be worth while to continue to collect facts in this direction until they may be available for some important use. Such as they are, therefore, I bring together the little that the butterflies have so far to show.

Specimens showing a mingling of the characters of the two sexes, called gynandromorphs, are by no means unknown. A hurried survey of the literature of the subject, most of which was collected many years ago by Dr. H. A. Hagen, shows seventy-one published examples of thirty-one species, mostly European; of these eight are Satyrids of three species, eighteen Nymphalinae of eleven species, including our *Vanessa atalanta* and *Euvanessa antiopa*, thirteen Lycaeninae of four species, twenty-four Pierinae of seven species and eight Papilioninae of six species. Most of these show complete bilateral distinction, the wings of one side being of one sex, of the other of the opposite sex; apparently the left side is usually female. A few cases have been observed in which the wings of one side are of mixed sexual characters, such as in *Cirrochroa aoris* (Westwood), *Laertias philenor* (Strecker), *Argynnis paphia* (Röber), etc. Westwood even gives a plate of his magnificent *Thesaurus entomologicus oxoniensis* to such insects, mostly butterflies, in which eight different kinds are figured, and they present an extraordinary appearance. Dr. W. J. Holland writes me that he has a *Papilio polyxenes* collected by Mead, in which the abdomen is female, while the wings have the male coloring. In our

own country examples of gynandromorphism have been few. Edwards has figured one or two, and with the exception of *Cyaniris pseudargiolus*, all that have been recorded are *Papilioninae*,—*Laertias philenor*, *Jasoniades glaucus* and *Papilio polyxenes*. The most interesting is that of *J. glaucus*, since the female side is represented by the dark form *J. glaucus glaucus*, forming a fine contrast to the yellow male side. In that of *Cyaniris*, androconia even were found on the male side. In one of *Papilio polyxenes* the division affects the abdomen, half of which is male, half female, as the appendages show.

Then there are those malformations which affect some point of the structure. Sometimes the antennae are disturbed, as when the distortion of a joint throws the stalk out of line or when a suture becomes very oblique; some instances of this sort have been given in our text under *Oeneis semidea*, *Vanessa atalanta*, *Speyeria idalia* and *Eurymus philodice*. But it is more likely to affect the neurulation, numerous instances of which have been recorded abroad, and among the manuscripts of the late Lefebvre in the French entomological society's library are notes and figures of some that are very curious and which have never been published. A few minor ones among our butterflies are noted above, under *Oeneis semidea*, *Euploia claudia* and *Argynnis atlantis*.

It even happens that one whole wing may be altogether wanting. Edwards gives such a case with *Iphiclides ajax*. So, too, Bertkau is said to have shown the Bonn natural history society a specimen of *Polygonia c-album* with the left hind wing wanting, and Harding states (*Entom.*, xvi:257) that he has bred a number of *Lepidoptera* with one wing almost or quite wanting, specifying among the butterflies two cases of *Lemonias aurinia* and one of *Limenitis sibylla*. But stranger far than these cases are a couple of instances, recorded and figured by the untiring Westwood, of a supernumerary hind wing. One was in *Colias rhamni*, the other in *Aglais urticae*, and in both the supernumerary wing was imperfect; in a third case a supernumerary wing appears to have been developed but to have been completely amalgamated with the wing it accompanied, which thereby had a vein and an ocellus too many! Still a fourth case is given by Röber of a supernumerary hind wing in *Najas populi*, similar to the first described by Westwood.

The catalogue is not yet exhausted. It sometimes happens that in the changes from caterpillar to chrysalis and from chrysalis to imago certain parts normally cast still adhere to the creature. Thus Lehmann raised a *Schoenis cinxia* in which a portion of the old caterpillar skin with its spines remained attached, even intimately, to the abdomen of the butterfly, so that it was not removable. And, most curious of all, the caterpillar head has been known in several instances, collated with care by Hagen and Westwood, to remain attached to the chrysalis and after that to the butter-

fly! One such instance is recorded in our text, after Zeller, with regard to *Euvanesa antiopa*, and another case, where the caterpillar head remained on the chrysalis, but from which the butterfly never emerged, is given under *Euphocaes troilus* and figured on Pl. 76, figs. 74 to 80. It is not a little curious that several such chrysalids of the same species were obtained by Dr. Thaxter and that Dr. Riley has found one of *Iphielides ajax*. Instances of imagoes with larval head have now been found on four different butterflies, not including those in which it reached only the chrysalis state. The possibilities of monstrous development seem indeed capable of taking still another direction; for in one of the European moths, *Melanippe montanata*, a precocious caterpillar has been found which developed the pectinated antennae and thoracic legs of the imago "without in any other way altering its appearance." A figure of this strange creature is given in Science, ii: 55.

OLIGORIA MACULATA.—The twin spot.

Hesperia maculata Edw., Proc. ent. soc. Philad., iv: 202, pl. 1, fig. 6, 2 figs. (1895).

Oligoria maculata Seudd., Syst. rev. Amer. butt., 61 (1872).

Pamphila maculata Edw., Cat. Lep. Amer., 54 (1877);—Chapm., Can. ent., xi: 191 (1879);

—French, Butt. east. U. S., 330 (1886).

Isoteinon maculata Hew., Cat. coll. diurn. Lep., 229 (1879).

Hesperia orthomenes Boid., MS.

Figured by Glover, Ill. N. A. Lep., pl. I, fig. 16, ined.

Away from me, and only love
The butterflies, gay triflers,
Who in the sunlight sport—
Away from me and sorrow!

HEINE.—(Transl.)

Imago (17: 6). Head covered above with closely intermingled, erect, pale fulvous and black hairs and scales, the former slightly tinged with olivaceous, beneath and close around the eyes covered mostly with pale, often dingy, straw yellow scales. Palpi having the basal joint covered with similar scales, the middle joint with the same at base, but immediately beyond heavily interspersed with blackish fuliginous scales, giving the palpus a very griseous appearance; the sides, especially in front, have a few longer, or a little more erect, blackish bristles; the protruded part of the apical joint is uniform, blackish fuliginous, but toward the base is flecked with some yellowish scales. Antennae blackish brown above, darkest on the club, faintly and very narrowly interrupted at the base of each joint of the stalk with pale yellowish, the interruption sometimes absent from the middle of the stalk, and generally more distinct than elsewhere toward its extremity, beneath dingy buff, interrupted excepting on the club and toward the extremity of the stalk with blackish at the tips of the joints; the colors of the upper and lower surface meet on the sides in oblique lines, so that the dark colors are broader at the tip, the pale at the base of the stalk joints; the outer side of the club is black, interrupted distinctly with buff at the base of the joints; otherwise the colors are uniform, but the crook and the usual portion of the club adjoining it is naked, fusco-luteous. Tongue black, at tip castaneous or testaceous.

Thorax covered above with fuliginous scales and hairs, largely intermingled with long, dull, olivaceous-tawny hairs, which become more distinctly tawny on the patagia; beneath with mingled pale, dull yellowish, fuliginous and a few blackish scales and hairs; femora and tibiae dark brown, flecked on the inner and upper surface of both

parts heavily, and on the outside (of the femora only) lightly with pale yellow, the femora fringed beneath with long, pale dirty yellow and blackish hairs, the former in excess; upper surface of tarsi dark brown, under surface buff; under surface of fore tibiae silvery buff; leaflet of fore tibiae glossy dark buff; spurs brownish beneath, brownish yellow above; spines bright luteous; claws the same, a little dusky at tip; pad fuliginous.

Wings above rich, dark brown, with a slight ruddy tint in the middle, particularly of the hind wings. *Fore wings* lightly flecked on the basal fourth, especially next the costal margin, with elongate, tawny scales; outer half of the wing with four or five pseudovitreous spots, covered with nearly colorless scales; two (♂) or three (♀) of these are small, subquadrate, usually a little longer than broad, situated in the interspaces between the second (♂) or third (♀) and fifth superior subcostal nervules, the uppermost of those in the ♀ in the middle of its interspaces, all arranged in a straight line, scarcely inclined outward from a right angle to the costal margin; the other two are larger, and situated in the median interspaces, the upper, between the second and third median nervules, being the smaller and transversely lunate, opening outward, about twice as large as one of the subcostal spots, and situated in the middle of the basal half of its interspace; the other spot in the interspace below is subulate or fabiform, but transversely oblique, directed from above downward and outward, its upper extremity about midway between the upper spot and the base of the second median nervule; it is generally about twice as large as the upper median spot; all the spots are considerably larger in the ♀ than in the ♂. Outer margin very faintly and very narrowly marked with a pale line. Fringe pale fuliginous, sometimes with a slight yellowish tinge, its basal third of the same brown as the ground color of the wing. *Hind wings* with a minute, round, whitish, vitreous spot in the middle of the upper median interspace, which is always absent from the ♂, and sometimes very indistinct in the ♀, and occasionally accompanied in the ♀ by a dot in the lower median interspace at the same distance from the margin. Fringe slightly paler than on the fore wings, but similarly obscured at the base.

Beneath of a duller brown than above, but tinged faintly and uniformly with dark dull tawny excepting on the lower half of the fore wings, where it becomes more or less fuliginous. *Fore wings* with a scarcely perceptible lighter cloud next the middle of the outer margin, the spots of the upper surface repeated and, in the lower half of the medio-submedian interspace, a broad, comet-like whitish dash, more distinct in the ♀ than in the ♂, flecked throughout, but especially apically, with brown, commencing just beyond the middle of the interspace where it is most distinct, and fading out before reaching the outer border, sometimes when but half way there. Outer margin edged as above. Fringe fuliginous, darker on the basal than the apical half. *Hind wings* with three subequal white spots, sometimes tinged with yellow, about the size of the upper median spot of the fore wing; two of them are situated side by side in the median interspaces, the lower in the middle of its interspace; the third is in the middle of the subcostal interspace; the lower median spot is nearly round, the upper median usually longitudinally oval and slightly larger than the lower; the subcostal varies but is usually longitudinally oblique in position and suboval in form. Fringe very much as in the fore wings.

Abdomen covered with dark fuliginous brown, overlaid above by numerous, dark tawny scales and beneath by pale dirty yellow scales, which beneath prevail on the apical third of the joints and form the apical clothing of the whole of the terminal joint. Upper organ of the male appendages (37:38) with the hook scarcely longer than the breadth of its base, where it is encroached upon above by the gibbosity of the centrum, its tip bluntly docked; lateral arms less bluntly pointed than the hook, nearly reaching its tip. Clasps twice as long as broad, the upper border with a basal rounded expansion and beyond the middle a slightly upturned, small, rounded lobe longer than broad, scarcely separated from the part just beyond, consisting of a very small blunt tooth, by a slight, transverse incision.

Measurements in millimetres. Length of tongue, 20 mm.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	16.		16.75	18.		18.
antennae.....	8.5					
hind tibiae and tarsi..	8.75					
fore tibiae and tarsi..	5.7			6.		

Described from 2♂, 2♀.

Caterpillar. *Last stage.* Head oval, oblique, densely pubescent, slightly granulated, light brown. Thoracic shield light brown; body slender, pale green, finely pubescent, the last two segments deeper green. Length, 25 mm. (After Chapman.)

Chrysalis. Cylindrical, dull green, pubescent, especially about both extremities; the head case blunt, wing cases smooth, a pair of flat tubercles on the ventral side of the 4th-8th abdominal segments; cremaster broad, triangular. Length, 20 mm. (After Chapman.)

This is a southern butterfly (32:6), a member of the Carolinian fauna and found to all appearance only on its southern border along the Gulf, having been first reported from New Orleans (Norton), and since taken in abundance in Florida in various places, as at Indian River (Palmer), Haulover (Schwartz), Gainesville (Miss Peirce) and Brevard Co. (Wittfeld). It is also reported by Strecker as found in Georgia.

Its only claim to a place in this work is because it was taken in a single instance near Albany, N. Y. by Meske in 1866, according to Lintner.

It is an early butterfly, since specimens obtained at the end of March at Indian River by Palmer were in a bad condition, but apart from this single item we know nothing of its life history.

Its occurrence in New York shows that it must occur in many other places, so that we may look for a large extension of the region marked on the map. Its life history is of course of the first importance.

LIST OF ILLUSTRATIONS.—OLIGORIA MACULATA.

- | | |
|--|---|
| General. | Pl. 37, fig. 33. Male abdominal appendages. |
| Pl. 32, fig. 6. Distribution in North America. | 42:16. Neurulation. |
| Imago. | 60:4. Side view of head and appendages |
| Pl. 17, fig. 6. Both surfaces. | enlarged, with details of leg structure. |

LEREMA SCUDDER.

- | | |
|--|---|
| Lerema* Scudd., Syst. rev. Amer. butt., 61 (1872). | Hesperia pars Auctorum. |
| | Pamphila pars Auctorum. |
| | Type.— <i>Papilio accius</i> Smith-Abb. |

I trust not in the lily's chasteness;
The color'd fop, the butterfly,
Toys with her, kisses, round her flutters,
Till lost is all her purity.

HEINE.—(Transl.)

Imago (60:3). Head large, clothed with transverse masses of rather short hairs; just outside the antennae, a short, spreading, appressed bunch of arcuate bristles, passing about one-fifth way around the eye. Front tumid, not greatly protuberant, extending a little and equally beyond the front of the eye; transversely, pretty strongly

* *λύπημα*, of frivolous action.

arcuate, scarcely depressed in the middle, about two and one-fourth times broader than long, subquadrate in form, the anterior outer angles rounded off, the front border straight, scarcely excised in the middle; in the centre is a slightly raised, circular, lens-shaped protuberance, apparently an *ocellus*, although unaccompanied by others, of about the size of the second antennal joint, found only in *actus* and in the female broken into two or three irregularities; separated from the vertex by a more or less distinctly impressed, straight line connecting the middle of the antennae. Vertex scarcely tumid, uniform, just attaining the height of the eyes, transversely almost flat, separated from the occiput, which is scarcely sulcate longitudinally in the middle, by a slightly impressed line, bent but little in the middle. Eyes large, full, nearly circular, naked. Antennae situated with their hinder edge scarcely behind the middle of the summit, separated from each other by about three times the diameter of the basal joints, the whole antenna of about the length of the abdomen, composed of from thirty-six to thirty-eight joints, of which from eighteen to twenty form the club, which is about half as long as the stalk; the crook excluded, it is nearly five times as long as broad, rather slender, increasing in size very gradually from the base fully to the middle of the outer half or at about the eleventh or twelfth joint from the tip of the antennae and beyond broadly rounded off; the crook is composed of seven or eight joints and forms a long and slender, regularly and gently tapering, pointed appendage, about four times as long as broad and considerably longer than the breadth of the club; middle joints of the stalk and the third from the base of the antennae about four times as long as broad. Palpi stout, twice the length of the diameter of the eye, profusely clothed with long scales, beyond which about half the apical joint protrudes; basal joint bullate, subpyriform, rather broader than long, with a tumid expansion on the inner side of the front of the distal extremity; middle joint bullate, ovate, the basal end rounded, the upper bluntly apical, a little arcuate, as broad as the basal joint, twice as long as broad; apical joint seated a little within the middle of the extremity of the middle joint, slender, cylindrical, bluntly pointed at tip, nearly as long as the breadth of the middle joint and fully three times as long as broad.

Prothoracic lobes rather small, subtriangular, strongly appressed, laminate, the inner edge straight, the lower a little convex, the upper outer edge regularly arcuate; it is nearly half as long again as high and as long as the diameter of the eye. Patagia similar to those of *Oligoria*.

Fore wing (42:19) twice as long as broad, the lower outer angle falling below the middle of the costal margin in the male, distinctly outside of it in the female; the costal margin straight, declivent at either extremity; outer margin gently and regularly convex, slightly bent in the middle in the female; the apex decidedly (δ) or somewhat (γ) produced. Costal nervure terminating a little beyond the middle of the costal margin; the subcostal not very closely approximated to the costal margin, the third nervule originating at the middle of the wing; cell two-thirds as long as the wing, moderately slender, largest just before the apex; first median nervule arising at about midway between the base and the second branch, the origin of which is below the third subcostal nervule; internal nervure short, straight.

Hind wing one-fourth longer than broad; the upper half scarcely longer than the lower portion of the outer margin, nearly straight, equal, rounded at the upper and lower angles; basal lobe of the costal region large. Subcostal and median nervures first forking at equal distances from the base, a little beyond the basal third of the wing.

Discal stigma of male inconspicuous, formed of a very slender, arcuate streak of dead black, erect rods crossing the middle and lower median interspaces, the latter almost transversely and so farther from the base than in the other genera. The scales contained in the stigma consist of exceedingly slender jointed threads, long and very slender scales, rounded and largest at the tip, besides short, truncate scales in some of the species; the cover scales when present, small and short.

Legs 2, 3, 1, in general considerably shorter than in the previous genus. Femora with a thick fringe of hairs beneath, long and decreasing in length from base to tip on all

but the fore legs, on these moderately long and nearly equal; hind tibiae with a rather thick fringe of hairs above, and a few similar hairs on middle tibiae. Femora 2, 1, 3; tibiae 2, 3, 1; tarsi 3, 2, 1, but in acclius 2, 3, 1; hind tibiae and tarsi together but little longer, longer than those of the middle pair together; fore femora two-thirds to three-fourths the length of the middle, one-fourth longer than the hind femora; fore tibiae rather more than half as long as the fore femora or the hind tibiae,* and somewhat less than half as long as the middle tibiae. Foliate appendage of fore tibiae very slender, tapering, attached to the middle of the apical two-thirds of the joint, extending some distance beyond it, five or six times as long as broad, arcuate on the apical two-thirds and bluntly pointed at the tip. Other tibiae furnished at tip with a pair of very long and slender, very unequal spurs, and the hind legs also with a secondary exactly similar pair in the middle of the apical four-fifths of the joint; lateral spines of middle and hind tibiae much as in *Oligoria*. Tarsal joints 1, 2, 3, 4, 5, excepting on the fore legs, where the terminal is slightly longer than the preceding one. Fore tarsi from two-thirds to four-fifths as long as the middle, from three-fifths to three-fourths the length of the hind tarsi, all furnished with a triple row of pretty long spines, the apical ones of each joint a little longer; basal joint nearly or quite as long as the rest together (in acclius proportionally longer than in *lianna*), second joint barely half as long as first. Claws very small, regularly but not strongly arcuate, compressed, tapering. Pad moderately large, tumid. Paronychia blind, upper lobe compressed laminate, broad, falcate, with rounded tip, slightly curved, reaching to the tip of the claw, not strongly tapering; lower lobe minute, thread-like, less than half as long as the claw.

Abdominal appendages: Upper organ pretty large, broad and depressed, the centrum bent so that the main portion of the organ is horizontal; centrum deeply sub-cate above longitudinally; hook double, the arms widely separated, straight and horizontal, resembling the arms of a tuning fork; lateral arms separate, as long as the hooks, somewhat similar to and well separated from them. Claspers stout, broad and long, longer than the upper organ, nearly equal, the extremity considerably produced and hooked above.

This American group is limited to the mainland of eastern North America, between the fifteenth and the forty-second degrees of latitude; it has rarely been found far from the sea coast. One species is found in Central America; one in the southern and one in the northern states; the two latter have been taken, rather rarely, in southern New England.

The butterflies are of small size and the males are supplied with an indistinct, linear, discal streak on the fore wings. The color is very dark brown, with very slight markings, consisting, on the fore wings, of an extra-mesial curving or bent series of small white spots, and on the under surface of the hind wings of indistinct, intermingled cloudings of dark and pale blue, sometimes forming vague bands across the middle of the wing. The genus is remarkable for sometimes possessing ocelli in the perfect state—the only instance known among butterflies. One of the New England species possesses them, the other does not. They vary in appearance in the sexes and are found upon the middle of the front, while in the lower Lepidoptera they invariably occur on the vertex. In this connection it should be noted that this genus falls at the very base of the Hesperidae, and that it is aberrant in several other points, as an examination of the table on page 1550 will show.

* Sometimes the hind tibiae are a little longer than the fore femora.

The butterflies are polygoneutic, at least in the south, probably wintering in the chrysalis. The caterpillars feed upon Gramineae (*Erianthus*, *Zea*) and perhaps upon Leguminosae (*Wistaria*).

The eggs are large, white, distinctly and finely reticulate with raised lines, and the cells very finely punctuate. The caterpillars are nearly white, sprinkled with darker dots, and according to Abbot faintly striped with green. The chrysalids are greenish white, with a long and slender, straight, tapering frontal prominence.

Two species are found in eastern North America.

EXCURSUS LXXVI.—THE COLORING OF BUTTERFLIES AS
RELATED TO THEIR DISTRIBUTION.

White, yellow and painted, there mustered a score
Of the butterflies—with them they brought 'Heliao po'r.

G. C. STENT.—*Songs from the Chinese.*

In butterflies as in other animals, species of the widest distribution usually display the greatest variety in their characteristic peculiarities; nowhere is this more true than in their coloring. Latitude, especially, has an influence in these alterations, and altitude produces almost precisely the same effects as latitude. Many species present so different an aspect at the northern and southern extremities of their range as to have been described as distinct species. So we may discover a difference of considerable importance in the coloring of butterflies as a whole, in passing from the tropics toward the poles, just as we observe a certain procession of color during the season, as one species is replaced by another. Every one is aware that the most brilliant tints among birds and butterflies are found in the tropics, while the sombre shades are more in sympathy with the gloomier subarctic regions. Prittwitz and Meyer-Dür have studied this question in the European Lepidoptera as a whole, and, with some exceptions, we may accept their generalizations as applicable to the butterflies of our own country.

The highest life of color in the wings of butterflies consists in sharply defined spots of red, blue, and yellow, and especially of red. These colors predominate in the tropical regions and are rare in alpine and subarctic districts. As we go north, the colors become less sharply defined, then gradually fade away or become blended with surrounding tints; the red first disappears, the blue follows, the yellow longest maintaining its hold, although Prittwitz considers the blue the most persistent. As soon as we leave the tropics these brighter colors are seldom seen in combination; and as we approach the higher temperate regions, we are constantly struck by the impurity of the tints. Take a single example from our common sulphur butterflies of the genus *Eurymus*; the more southern species have the

under surface of the hind wings of a clear canary yellow, and what few spots they possess are clustered into sharply defined markings next the margin; these features predominate until we arrive at the middle states, when a change begins; and on reaching Labrador we find the opposite extreme, a ground color of greenish yellow completely flecked with atoms of brown, giving the wing a grimy appearance; while the marginal markings are simply more densely clustered atoms, forming spots which gradually pass into the general dinginess of the wing.

This loss of purity and greater or less suffusion of markings is characteristic of northern and alpine forms, and is in perfect accord with another phenomenon, the appearance of those varieties or sports which are called examples of suffusion. Although they frequently seem very unlike the normal form, a little study always suffices to show to what species they belong. This disguise is produced, as already stated in the Excursus devoted to that subject, by the blending of certain colors, especially of black, white, or silvery tints, which normally occur at distinct parts of the wing. Now these suffusions have been known almost exclusively from the temperate regions, and have been artificially produced by subjecting chrysalids to unusual cold. A large number have been recorded in Europe, where they are commonest in the alpine districts of Switzerland.

These general changes of prevailing tints among butterflies from the tropics northward are perhaps less striking because so gradual, and seem fairly connected with physical conditions; color is dependent upon light, and of course the greatest intensity and duration of light is in the tropics; and the two phenomena are completely parallel. It is, however, harder to understand a very curious sport in one of our butterflies, which is known to have originated within recent years. There are a very few butterflies common to this country and Europe; and not a few entomologists have attempted to find some difference between representatives from either continent, thus far without real success. Within a few years the cabbage butterfly, as we have seen, was accidentally introduced from Europe, and has now spread widely; nor does any difference exist between European and ordinary American examples of this insect. But there suddenly appeared in this country a variety unknown to Europe, or, if known, excessively rare, in which the normal chalky white, which forms almost the only color of the upper surface of the wings, is replaced by a pale sulphur tint; probably few of our entomologists have not seen this variety, although from its resemblance on the wing to our commonest of butterflies, the clouded sulphur, it would ordinarily escape observation.

Table of the species of Lerema, based on the imago.

Hind wings beneath warm, ferruginous brown, outer margin enlivened with a bluish or lilaceous bloom; clasps of male abdominal appendages excised above just before the tip....	acclius.
Hind wings beneath cold, dark brown, the outer margin with a hoary bloom; clasps of male abdominal appendages excised far before the tip.....	hianna.

LEREMA ACCIUS.—The clouded skipper.

[Clouded skipper (Seudder); white spotted brown skipper (Maynard).]

- Papilio accius* Sm.-Abb., Lep. Ins. Geo., iii: 178 (1863); Ib., [manoco], Proc. Bost. soc. nat. hist., xi: 382 (1868).
Pamphila accius Westw.-Hew., Gen. diurn. Lep., ii: 523 (1852);—Chapm., Can. ent., xi: 191 (1870);—French, Butt. east. U. S., 327-328 (1896);—Mayn., Butt. N. Engl., 65, pl. 8, figs. 106, 106 a (1896).
Lerema accius Seudd., Syst. rev. Am. butt., 61 (1872); Butt., fig. 65 (1881).
Hesperia accius Hew., Cat. coll. diurn. Lep., 219 (1879).
Hesperia monoco Seudd., Proc. Ess. inst., iii: 178 (1863); Ib., [manoco], Proc. Bost. soc. nat. hist., xi: 382 (1868).
Hesperia nortonii Edw., Trans. Amer. entom. soc., i: 287-288 (1867).
Hesperia punctella Grote-Rob., Trans. Amer. ent. soc., i: 1-2 (1867).
Papilio curtus Abb., Draw. Ins. Geo. Br. Mus., vi: 75, figs. 102-104 (ca. 1800).
Hesperia chamis Bolad., MS.
 Figured also by Glover, Ill. N. A. Lep., pl. B, fig. 19; pl. E, figs. 8, 10, ined.
 [Not *Pap. curtus* Fabr.]

And then againe he turneth to his play,
 To spoyle the pleasures of that Paradise.

SPENSER.—*Mutopotmor.*

Imago (17:3, 7). Head covered above with mingled dull yellowish and grayish hairs, and in the central patches with dark brown scales; beneath with very pale, dirty yellow scales, which extend around the eye behind and above, becoming brighter yellow above; tuft on either side of the antennae of mingled blackish and dull yellow bristles. Palpi very pale dirty yellow at base, becoming scarcely more yellow and a little more brownish toward the tip, flecked rather profusely, especially toward tip, with black scales; apical joint dull brownish, flecked in front with yellowish. Antennae dark brown on the stem above, faintly annulated with pale at the base of the joints; upper surface of club blackish fuliginous with a purplish tinge, the basal third or fourth pale greenish nacreous; beneath nacreous, the apical half of the joints more or less brown anteriorly, the apical half of the club blackish; crook naked, brownish yellow, paling toward the tip. Tongue dark castaneous, a little infuscated laterally.

Thorax covered above with yellowish brown hairs, tinged slightly with olivaceous, concealing large, dark brown scales; prothorax with mingled yellow and dark brown scales, the former inclining to tawny; beneath with grayish yellow hairs, becoming yellowish anteriorly. Legs reddish brown, the upper and outer surface of the femora silvery gray, the sides of the rest of the leg inclining to the same, the tibiae growing darker above toward the tip; leaf-like appendage of fore tibiae glistening, pale brownish yellow; spurs brownish yellow; spines reddish luteous; claws reddish; pad dusky reddish.

Wings above very dark, uniform, warm, glossy brown. *Fore wings* with a scarcely arcuate series of minute, round or squarish, equal, white or silvery white, subcostal spots, arranged in a transverse series, the convexity inward, at right angles to the costal margin, scarcely beyond the middle of the outer half; in the middle of the basal two-fifths or half of the upper median interspace a square spot similar in size and color, and in the lower median interspace (in the ♀ only) a much larger, silvery white spot, rounded interiorly, straight or slightly concave exteriorly, just below the base of the middle median nervule; at the upper edge of the cell, opposite the base of the first subcostal nervule a minute, roundish white spot, also in the ♀ only; the other spots are larger in the ♀ than in the ♂. Discal stigma (43:20) slender, gently arcuate, nearly equal, tapering slightly at either end, but especially at the inner end, about seven times as long as broad, extending from the last divarication of the median to a little within the middle of the submedian nervule; it is composed of blackish slate-brown hairs, directed from above downward and compactly appressed; it is sometimes divided into two equal patches by the lowest median nervule. The nervules are usually

a little darker than the ground color of the wing, and the outer border is narrowly and indistinctly edged with black. Fringe blackish brown on the basal third, beyond varying from pale yellowish, narrowly interrupted with dusky at the nervure tips, to uniform dusky. *Hind wings* without markings, the lower half covered with hairs, having a slight olivaceous tinge; nervures, outer edge and fringe as in the fore wings.

Beneath very dark brown, considerably tinged with ferruginous, but at the outer border of both wings and before the middle of the hind wings flushed with a hoary bloom. *Fore wings* with the markings of the upper surface repeated beneath and in addition the ribs of the subcostal nervules sometimes dashed with whitish; at the outer border of the wing in a space which is bounded by a line running from the apex of the wing toward the middle of the outer half of the submedian nervure, stopping at the upper subcostal nervule and hence directed toward the outer border in the lower median interspace, distinctly but delicately flecked with pale bluish scales, giving it a hoary bloom; outer margin distinctly but delicately edged with a blackish line. Fringe as above, but more frequently interrupted with dusky. *Hind wings* with a faint, scarcely paler, roundish spot just beyond the middle of the costo-subcostal interspace; the hoary, bluish bloom, similar to, but perhaps fainter than, that of the fore wings, occupies two areas: one a basal patch below the subcostal nervure, terminated outwardly by a straight line, which connects the base of the upper subcostal and median nervules and continues to the inner border; the other occupies the outer border to a depth of about two interspaces, bounded laterally by a broadly curved line running from the tip of the upper subcostal and lower median nervules, or more often by a nearly straight line running from the former to the middle of the inner border, along which a narrow series of pale squarish spots is often present in the median and medio-submedian interspaces. Outer margin narrowly and distinctly edged with blackish. Fringe much as above.

Abdomen dark brown, rather sparsely flecked with olivaceous hairs above and especially on sides; beneath heavily tinged with yellowish brown, giving a grayish effect; upper organ of male appendages (37:12, 32) with the base of the hooks more widely separated than the tips; lateral arms forming equal compressed blades rounded at the tips, scarcely curving upward; they approach each other at their very base and then continue parallel and but slightly separated throughout. Clasps twice as long as broad, the extremity rounded, longest above, the upper margin pretty deeply excised just before the tip, leaving the extreme upper posterior angle produced as an upward directed, but incurved, triangular, laminate, pointed lobe.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of tongue, 10 mm.						
Length of fore wing.....	15.	17.	17.75	16.	18.5	19.5
antennae.....	8. (♀)	8.5	9.	8.	8.4	9.35
hind tibiae and tarsi..			9.		8.4	9.35
fore tibiae and tarsi..	4.85		5.6	4.25	5.	5.5

Described from 11♂, 11♀.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wing; the scales contained in it consist of jointed threads (51:6a) in the heart of the stigma, the joints apparently enlarged slightly at the incisures; in the apical portion are found some very long and large, slender scales (6b) with rounded tip, a little larger apically than at base; the cover scales (6c) are small, subquadrate, with a wavy apical margin. In the vitreous subcostal spots of the female will be found some transverse, oval scales (6d), finely striate, with wavy reflections and entire and regular margins.

Egg (66:36). Cells in the middle of the egg very regularly pentagonal, about .03 mm. in diameter; below growing broader than high, so as to have the longer diameter near the base of the egg .04 mm. The cells are filled very irregularly with punctures which appear to be linear, giving them the appearance in certain lights of supporting a short hair, which caused the artist to so represent it on the plate, but none can be seen

on the profile; the punctures vary in number but are usually about ten or eleven in a cell. Diameter of egg, 1.08 mm.

Caterpillar. *Last stage* (77: 36). Head white, edged posteriorly with black, the sides of the front with an oblique black streak and the frontal suture red. Body pale green, apparently with a hoary bloom, with a dusky dorsal line, and laterodorsal, prepristigmatal and infrastigmatal dark green stripes; dorsal thoracic shield black; thoracic legs black. Length, 37 mm. (According to Abbot and Smith).

Another description. Head rather small, oblique, oval, flattened frontally, white with a black band around top and sides, a black streak down middle of face and a short black streak on either side of this last, and not reaching the band at top. Thoracic shield black. Body slender, nearly white, but under the lens mottled and dotted with darker lines and points, the rings on the posterior half of each segment more prominent and less dotted. Length, 34 mm. (After Chapman.)

Chrysalis (85: 46). Pale green, incisures of abdomen, edges of wings and tongue pale pink. Length from tip of tubercle to end of cremaster, 28 mm.; length of tubercle, 3 mm.; of cremaster, 1.75 mm.; of tongue beyond end of wings, 10 mm.; height of thorax, 5.5 mm. (According to Abbot and Smith).

"Slender, smooth, white, the head case tapering into a slender pointed beak." (Chapman).

Distribution (32:7). This butterfly is a member of the Carolinian fauna but has been reported so far only along the coast, excepting in a single instance, French reporting it to be found in southern Illinois. It extends beyond our southern borders, having been taken by Palmer at San Luis, Hacienda de Bledos and Saltillo, Mexico; along the Gulf coast it has been found in Louisiana, Demopolis, Ala. (Grote) and Florida where it extends to the Keys (Palmer). It follows the Atlantic coast far northward, having been taken at Indian River, Florida (Wittfeld), Wilmington Island (Oemler), and other parts of Georgia (Grote and Robinson) and North Carolina (Edwards), eastern Pennsylvania (French) and Atlantic City, N. J. (Aaron).

It has been repeatedly taken in southern New England in Farmington (Norton), Guilford (Mus. Yale College) and New Haven, Conn. (Smith), and has even been found in Massachusetts.

Food plant. Abbot and Smith figure this species upon *Wistaria frutescens* D. C., one of the Leguminosae, but Abbot says it "feeds on blades of Indian corn," *Zea mays*, a paniceous grass; so, too, Dr. Chapman has reared it upon the woolly beard-grass, *Erianthus alopecuroides* Ell., one of the Gramineae.

Life history. In the north the single record of its occurrence is April 2, in Connecticut (Norton). In the south it is apparently trigoneutic, for Dr. Palmer took it in different parts of Mexico in the first half of July and again in September and October. He also brought specimens from Florida Keys taken in the first half of July and Dr. Oemler sent me a female from Wilmington Island, Georgia, taken at the end of October. Dr. Chapman found the larva August 2 at Appalachicola, Fla. Abbot, moreover, bred the butterfly April 20 and June 29, all which indicates three broods in the south: April, end of June and September. Maynard, who

has often visited Florida, says that it is found in the south "from early spring until late in the autumn." Abbot found the chrysalis state to last eight days in June. Its early appearance at the north indicates hibernation in the chrysalis.

Fitch describes in his unpublished notes a pupa which he ascribes to this species but by error.

Desiderata. The chance for any enlargement of our knowledge of this insect from observations in the north is small on account of its extreme rarity; observers by the sea-shore are in the best position. The life history as given here is based upon quite too fragmentary data and needs verification and amplification at every point; this would probably be easy to do in the south. None of the larval stages are sufficiently described, nor is the chrysalis, and the egg only from dead material; the habits of the larva, if they have any peculiarity, and the mode of suspension of the chrysalis are alike unknown. How is the winter passed and if in chrysalis in what sort or a concealment, and how does it differ from that made for the chrysalids of the fair season?

LIST OF ILLUSTRATIONS.—LEREMA ACCIUS.

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| Pl. 66, fig. 36. Egg. | Pl. 37, figs. 12, 32. Male abdominal appendages. |
| Caterpillar. | 42: 19. Neurulation. |
| Pl. 77, fig. 36. Mature caterpillar. | 43: 20. Discal stigma of male fore wing. |
| Chrysalis. | 51: 6. Scales of the discal stigma. |
| Pl. 85, fig. 46. Chrysalis. | 60: 6. Side view of head and appendages enlarged, with details of leg structure. |
| Imago. | General. |
| Pl. 17, fig. 3. Male, half of upper surface. | Pl. 32, fig. 7. Distribution in North America. |
| 7. Female, both surfaces. | |

LEREMA HIANNA.—The dusted skipper.

[Four spotted brown skipper (Maynard).]

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| <i>Hesperia hianna</i> Scudd., Proc. Bost. soc. nat. hist., xi: 382-383 (1868). | 106, 106a (1886). |
| <i>Pamphila hianna</i> Kirb., Syn. catal. Lep., 600 (1871);—French, Butt. east. U. S., 347 (1886);—Mayn., Butt. N. Engl., 65, pl. 8, figs. | <i>Lerema hianna</i> Scudd., Syst. rev. Am. butt., 61 (1872).
Figured also by Glover, Ill. N. A. Lep., pl. T, fig. 1, ined. |

So in his silken sepulchre the Worm,
Warm'd with new life, unfolds his larva-form;
Erewhile aloft in wanton circles moves,
And woos on Hymen-wings his velvet loves.

DARWIN.—*The Botanic Garden*.
O, I am out of breath in this fond chase!

SHAKESPEARE.—*Midsummer-Night's Dream*.

Imago (10: 31-32). Head covered above with mingled yellowish brown and blackish hairs, the former tinged anteriorly with ferruginous, and behind the antennae with blackish fuliginous scales; tuft on either side of the antennae of black or ferruginous bristles; eye narrowly encircled, excepting in front, with white scales, interrupted rather broadly at the lower posterior portion of the eye with mingled fuliginous scales and ferruginous hairs. Palpi whitish on the middle of the front, especially toward the

upper edge, but the sides and tip broadly margined with brownish yellow or dark buff, the whole furnished with sparsely scattered, very fine black hairs; above without any white; terminal joint brownish yellow, flecked in front with paler scales. Antennae above rather dark brown, the base of each joint narrowly interrupted with whitish, which broadens anteriorly; beneath white or nacreous to the end of the club, and even in a slender stripe along the posterior side of the crook to its very tip; rest of crook naked, and dark castaneous.

Thorax above covered with dark brown and brownish ferruginous hairs, mingled anteriorly with many blackish ones; beneath with ferrugineo-castaneous hairs, which are paler at their base. Femora dark purplish brown, above and outside flecked with many silvery gray scales; tibiae and tarsi dark brown, flecked beneath with many pale yellowish, or on the fore legs whitish, scales; leaf-like appendage of fore tibiae pale, glistening, brownish yellow; spurs pale brown, tipped rather largely with reddish luteous; spines reddish luteous; claws the same; pad dusky.

Wings above dark slate brown, slightly paler on the outer half, sparsely flecked with yellowish brown, the nervures blackish. *Fore wings* with a transverse, straight series of three subequal, white, subcostal spots, generally increasing in size toward the costal border and arranged at right angles to it, or at a very little less than a right angle viewed from the inner side, at a little beyond the middle of its outer half; in the middle of the basal half of the upper median interspace a white spot of similar size; these markings are of about equal size in the ♂ and ♀; in the ♀ there is also a slightly larger, roundish or transversely quadrate spot in the lower median interspace, below a point midway between the base of the upper median interspace and its spot and also a minute spot or speck in the cell at the base of the first subcostal nervule. Discal stigma exceedingly obscure, composed of two slender, blackish brown lines, the outer straight, extending from the last median divarication to the lower median nervule in a direction toward the middle of the basal two-fifths of the submedian nervule; the inner extends from the middle of the basal four-fifths of the submedian nervule, parallel to the outer streak, fully to the middle of the medio-submedian interspace, is there broken, and then curves upward and meets the extremity of the outer streak; outer margin of the wing very slenderly edged with a blackish line. Fringe pale, dirty yellowish, more or less flecked with dusky, especially at the nervure tips, its basal third infuscated. *Hind wings* without markings; outer margin and fringe as in the *fore wings*.

Beneath very dark brown, the outer half of the wing made hoary gray by a more or less profuse admixture of hoary scales. *Fore wings* with the markings of the upper surface repeated beneath, the hoary flush of the outer half of the wing deepening apically, especially above the lower median nervule, where it is deepest, in a broad, lunate area whose points rest on the apex of the wing and the tip of the nervule mentioned; outer margin edged narrowly with a blackish line. Fringe as above. *Hind wings* with a small, round, dark edged, white spot close to the base of the costo-subcostal interspace, and occasionally a second smaller one in the same interspace, midway between the first and the outer margin; the hoary flecking of the outer part of the wing is somewhat distinctly delimited at the middle of the wing and increases in depth apically, interrupted, however, a little before the middle of its area, by a narrow band of dusky connected spots, more or less distinctly free from hoary flecking; outer margin edged narrowly with a blackish line. Fringe as above.

Abdomen blackish brown, flecked with grayish at the apices of the segments, indistinctly above and at sides, distinctly and more largely below. Upper organ of the male appendages (37:36) with the tips of the hooks more widely separated than the base; lateral arms similar to those of *acclus* but a little more curved and pointed at the tip; i. e. more ensiform, separated throughout as widely as the hooks. Clasps much larger than in *acclus*, nearly two and one-half times longer than broad, the extremity strongly rounded, longest in the middle, above produced to an upward and slightly forward directed triangular tooth, separated by a deep but narrow excision from the posterior lobe of the upper margin, which is scarcely larger, directed backward and upward, and rounded at the tip.

Measurements in millimetres.	MALES.			FEMALES.		
	Smallest.	Average.	Largest.	Smallest.	Average.	Largest.
Length of fore wing.....	15.55	16.5	17.5	16.5	17.	18.
antennae.....	7.6	8.	8.5	7.5	8.25	8.5
hind tibiae and tarsi.....	6.6	7.	7.25	7.	7.25	8.
fore tibiae and tarsi.....	4.6	5.25	5.25	4.7	4.6	5.5

Described from 4 ♂, 3 ♀.

Accessory sexual peculiarities. The discal stigma of the male has been described under the wing; the scales contained in it are very simple in character and of less variety than usual; next the base there are found some of the two-pronged rods (51:3 d) of no great length or slenderness, and long and slender subspatulate scales (3 a); at the tip are found very slender and elongated jointed scales (3 b), besides some moderately large, equal and slender boat-shaped androconia (3 c).

Variations. Mr. F. H. Sprague has in his collection an interesting ♀ specimen, taken in Wollaston, Mass., in June, in which not only are all the white spots larger than usual, and the uppermost of the three subcostal spots of the fore wing not half the size of the succeeding, but a very different appearance is given to the under surface of the hind wings by the presence of white scales in the interrupted extra-mesial series of dusky spots, forming slender transverse bars in the interspaces, the series forming a right angled band having its angle beyond the cell in the middle of the outer half of the wing, and its first spot the here slightly enlarged spot which sometimes occurs in the outer portion of the costo-subcostal interspace. In addition to this outer series there is, subparallel to it, a strongly arcuate, basal series of dark edged white spots, the regular spot of the base of the costo-subcostal interspace forming one end of the series, and an entirely similar and equally large one occupying a corresponding position in the medio-submedian interspace the other end, while between, the spots are very faint and slight. The specimen measures 17.5 mm. in length of fore wing, and on its under surface varies from the normal markings of the species toward those of *Lerema loammi* Whitn., of the south.

Distribution (32:8). This interesting and characteristic member of the Alleghanian fauna has been found, so far, only in a narrow belt of territory stretching from the Atlantic to the western plains north of Lat. 40°. West of New England it has been taken in comparatively few places: in New York, near Brooklyn, Long Island (Morrison) and near Albany (Lintner); in Michigan, according to Strecker; in the township of Ohio, Ill. (Morrison); in Wisconsin common (Hoy); in Iowa according to Strecker, and in Nebraska according to Edwards.

In New England it is confined to the southern portions and is known from but few localities; the northernmost being at Milford, N. H., where it is said to be somewhat common (Whitney); besides which it has been found at several places in the vicinity of Boston,—Quincy and Dorchester (Sanborn), Malden and Wollaston (Sprague), at Springfield, Mass. (Emery) and near New Haven, Conn. (Smith, Mus. Yale Coll.).

History. According to the observations of Messrs. Lintner and Sprague it appears to be single brooded. The earliest butterflies appear about the 25th of May—perhaps earlier, for females have been taken then—and the last specimens captured were taken just past the middle of June. This covers the whole of our meagre knowledge.

Mr. Meske remarks that when at rest both pairs of wings are closely folded together over the back.

Desiderata. This insect has been so seldom found that we are totally ignorant of almost every thing about it that is desirable to know. We have the most meagre possible material for constructing the history of the butterfly and all dates of capture with the condition of the specimen should be recorded until we can learn when and where to expect to find it.

LIST OF ILLUSTRATIONS.—LEREMA HIANNA.

Imago.

Pl. 10, fig. 31. Male, both surfaces.

32. Female, upper surface.

37: 36. Male abdominal appendages.

Pl. 51, fig. 3. Scales of the discal stigma of the fore wing of the male.

General.

Pl. 32, fig. 8. Distribution in North America.

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